THE

SAIDAPET EXPERIMENTAL FARM

MANUAL AND GUIDE.

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MANUAL AND GUIDE.

PREPARED UNDER THE ORDERS OF GOVERNMENT

BY

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PREFATORY REMARKS.

This compilation has been prepared in order to bring together, in a form convenient for reference, the most interesting and valuable writings, referring to the practice of agriculture in this Presidency, which are to be found scattered through the annual and special reports, submitted by the agricultural officers of the Madras Government during the past ten years; many of these reports being either out of print or otherwise not available to the public.

A short guide to the Saidapet Experimental Farm has been added to the compilation in order that the farmer and agricultural student may be able to comprehend the circumstances under which the results and experience narrated have been gained. This guide will enable any one to judge whether it is likely, under the conditions with which he himself has to deal, that similar results would be obtained if he adopted the practices detailed; he will also be assisted in deciding what modifications of them would in his case be advisable. He should, however, not forget that in farming it is impossible to reduce, to the accuracy and preciseness usual in a manufactory, the results of the operations performed. Agriculture is, more than any profession, dependent on Nature for success.

Agricultural experiments are in all countries surrounded by many difficulties; and only to be carried out at great cost to the experimenter; although the results obtained may be of incalculable value to the public at large. I might quote on this subject from the writings of many of the leading authorities on scientific agriculture, but will only give the following extract from Von Thaer's "Principles of Agriculture:"—

"*These experiments, it is true, are not easy; still they are in the power of every thinking husbandman. He who accomplishes*

...ne, of however limited application, and takes care to report faithfully, advances the science, and, consequently, the practice of agriculture, and acquires thereby a right to the gratitude of his fellows, and of those who come after. To make many such is beyond the power of most individuals, and cannot be expected." In this country, however, agricultural experiments have been and are surrounded by many difficulties, which in other countries are almost unfelt. The almost entire absence of reliable information regarding the rational performance of the tillage of the ground, of the culture of any of our common crops, or of the management of live stock under the conditions with which we have to deal, has been a drawback to progress, which it is scarcely possible to overrate. The want of co-adjutors, working for the same object as the officers of Government, has also been a great obstacle to the collection of reliable data on which to base conclusions of a definite nature.

On the Saidapet Farm numerous alterations, rendered necessary, after it had been in operation some years, by a change in its objects, together with the difficulty of obtaining that uniformity of condition in preparation for experiments, which is necessary for the collection of reliable data, owing to the apathy, ignorance, and carelessness of the laborers, and to the impossibility which exists for Europeans to remain all day exposed to the sun in the plains, have retarded the progress of research greatly. At the same time the chances of success attending experimental work are always reduced by the extremes of heat and moisture, of flood and drought, which characterise the climate, and by the depredations of birds, animals, and insects, as well as from the general habits of allowing domestic animals to graze at large, and of petty pilfering from the fields.

It should not be forgotten by the reader that this work only attempts to show the local agricultural experience gathered at Saidapet up to the present time; as this has been gained at one place only, and in a very limited period, and as,

besides the farm here, there have been no similar institut[illegible] in any part of the Presidency, it is quite possible that wide[illegible] and fuller experience will controvert many of the opinions which are expressed; on many points light will doubtless be thrown in the future, and many results will be negatived or confirmed by further trial.

Such a work as this is can only remain of value for a short time, but it will be, it is hoped, of use to the public in diffusing sound ideas regarding improved methods of agriculture. As far as possible it has been my object to bring down the data given to the most recent possible date, and thus perhaps some as yet unpublished figures will be found in the work.

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SAIDAPET,
5th November 1878.

CONTENTS.

Chapter		Page
I.—	Guide to the Saidapet Experimental Farm	1
II.—	The Treatment of the Land	9
III.—	Manures and Manuring	19
IV.—	Crops	35
V.—	Livestock	71
VI.—	Foods and Feeding	91
VII.—	Implements, Machines, and Tools	103
	Index	117

MAP
of
THE SAIDAPET EXPERIMENTAL FARM

THE

SAIDAPET FARM MANUAL.

CHAPTER I.

GUIDE TO THE SAIDAPET EXPERIMENTAL FARM.

THE farm is situated on the northern bank of the Adyar river, which forms its southern and eastern boundaries, between 5 and 6 miles south of Madras, in the Saidapet Taluk of the Chingleput District.

The district around Saidapet is chiefly occupied by rocks of the secondary, tertiary and recent ages, the remainder of the area being taken up by rocks of a metamorphic form. Mr. Foote classifies the rocks as follows:—

"The following tabular statement illustrates the various groups into which the rocks of the Madras area have been classified:—

Recent or quaternary ..	Blown sands. Alluvium, marine and fluviatile. Laterite and Conjeveram gravels.
Tertiary	Gritty sandstones. Cuddalore sandstones.
Secondary	(Cretaceous ?) Jurassic, Rajmahal plant beds.
Sub-metamorphic ..	Cuddapah group.
Metamorphic	Gneissic series."

The formations chiefly prevalent are:—

"1st. *The Blown Sand.*—These sub-aerial deposits are of no great extent or importance. The greatest width obtained by this coast ridge may be about a mile.

"2nd. *The Alluvial Formations.*—These are of two classes, marine (including estuarine) and fluviatile, but they are nearly undistinguishable in character, and at many points graduate into each other imperceptibly. Their general character, as seen at the surface, is that of pure, or nearly pure, silicious sands; but beds of black, blue or grey clay occur largely below the surface in the marine alluvium near Madras; these are, however, much less frequent in the fluviatile alluvium higher up the river valleys. The river alluvia are of more interest than the marine, because they afford evidence of some remarkable changes within the human period in the courses of several of the principal rivers in the district.

"3rd. *Lateritic Formations.*—The formations classed under the above heading are of three principal kinds, namely, clayey conglomerates, gravels and sand which occur distributed over nearly the whole of the area under consideration. These formations are found constantly graduating into

each other in such a manner that they can only be regarded as parts of one and the same deposit, however various the appearance of the different members. In the Madras areas and to the north of Madras in the Nellore District, the character of the lateritic formations is considerably different from that of the representatives of the same series further south in Trichinopoly and South Arcot Districts, the difference consisting in the much greater frequency of conglomerates and in the presence of large quantities of quartzite pebbles enclosed in the conglomerates. The laterite gravels frequently contain pebbles of quartzite and gneiss mixed with the pisiform ferruginous pellets in varying proportion according to their proximity or distance from the older quartzite yielding rocks. The sands associated with the lateritic conglomerates and gravels show considerable variety in texture and color, the latter depending on the percentage of iron. They not unfrequently contain a large quantity of clay, and are then apt to cake and harden, but without the excessive fissuring noticeable in purer clays. These sandy beds are frequently found overlying the highly ferruginous beds and form to a great extent the soil of the laterite areas."

The climate of the district is, compared with many others of this Presidency, good; for the great heat is considerably lessened by the sea breezes over a great part of its area, and the rainfall is more considerable than in other neighbouring districts. The following table gives the average data of the meteorology of Madras from the records of the Observatory; the situation of which is Latitude 13° 4' North, Longitude 80° 15' East:—

Months.	Reduced Atmospheric Pressure.	Temperature of Air.	Temperature of Evaporation.	Percentage of Humidity.	Greatest Solar Heat in Vacuo.	Maximum in Shade.	Minimum in Shade.	Minimum on Grass.	Rainfall in Inches.	Wet Days.	General Direction of Wind.	Daily Velocity in Miles.	Percentage of Clear Sky.
April ...	29·824	84·3	77·4	74	139·0	92·7	77·4	74·3	0·71	1	S.E. by S.	190	60
May ...	29·730	87·2	78·2	67	140·5	97·6	81·0	78·6	2·07	2	S. by E.	229	60
June ...	29·698	87·0	76·4	62	135·0	98·2	80·9	78·3	1·99	7	S.W. by S.	218	35
July ...	29·716	85·0	75·7	66	133·0	95·6	79·0	76·5	3·81	12	S.W.	207	35
August ...	29·749	83·6	76·0	71	133·1	93·2	77·6	74·8	4·53	12	S.W. by S.	180	31
September	29·774	83·1	76·0	73	136·5	92·1	77·3	74·4	4·83	10	S.W. by S.	160	36
October ...	29·841	80·8	75·5	79	133·3	88·3	75·6	72·6	10·99	12	East.	124	43
November	29·933	77·5	72·6	79	131·5	84·0	72·5	69·1	13·17	13	N.N.E.	168	43
December ...	29·979	75·3	70·2	78	133·6	82·1	70·2	65·7	5·10	7	N.N.E.	179	49
January ...	29·995	74·8	68·9	75	134·0	82·8	67·9	62·4	·99	2	N.E. by E.	149	64
February ...	29·962	76·8	70·8	75	134·5	85·4	69·1	63·8	·30	1	East.	133	74
March ...	29·904	79·9	73·5	74	136·5	88·4	72·0	67·6	·45	1	S.E.	151	76

In the next statement the rainfall records made at Saidapet during eight years are tabulated; these show considerable variations from the Observatory figures.

Months.	1870-71.			1871-72.			1872-73.			1873-74.			1874-75.			1875-76.		
	Rainfall in Inches.	Falls.		Rainfall in Inches.	Falls.		Rainfall in Inches.	Falls.		Rainfall in Inches.	Falls.		Rainfall in Inches.	Falls.		Rainfall in Inches.	Falls.	
		Under one Inch.	Over one Inch.		Under one Inch.	Over one Inch.		Under one Inch.	Over one Inch.		Under one Inch.	Over one Inch.		Under one Inch.	Over one Inch.		Under one Inch.	Over one Inch.
April	...	...	...	...	...	...	...	...	...	2·38	2	1	...	...	...	...	...	...
May	...	...	...	·33	1	...	7·55	1	2	...	...	...	6·79	2	1	...	...	...
June	8·32	6	2	1·44	4	...	1·41	1	1	1·68	6	...	6·66	4	3	·32	4	...
July	8·48	8	3	6·44	4	2	2·95	5	1	1·50	9	...	5·46	7	1	·66	3	...
August	7·52	5	3	1·79	3	...	6·46	7	2	3·16	6	1	2·34	4	1	9·44	10	2
September	6·90	5	2	8·23	1	4	4·96	5	2	7·24	5	2	10·59	9	3	4·21	4	1
October	16·63	8	4	6·21	5	2	18·26	5	5	12·30	11	7	21·91	3	7	5·30	10	2
November	5·44	11	1	26·64	7	7	31·13	6	10	8·91	13	1	9·25	3	4	15·52	6	5
December	1·20	3	...	·19	1	...	7·22	2	3	10·90	2	3	5·11	3	2	2·99	6	1
January	1·20	1	1	...	...	...	...	...	...	...	...	...	·10	1	...	...	...	...
February	·68	1	...	·75	1	...	6·23	2	2	...	...	...	...	...	...	...	...	...
March	·70	2	...	·06	1	...	...	...	...	...	...	...	·77	1	...	...	...	...
Total ...	57·07	50	16	52·08	28	15	86·17	34	28	48·07	54	15	68·98	37	22	38·44	43	11

Months.	1876-77.			1877-78.			Saidapet Farm, Average 8 Years.							
		Falls.			Falls.			Daily Falls.			Percentage of Total.			
												Falls.		
	Rainfall in Inches.	Under one Inch.	Over one Inch.	Rainfall in Inches.	Under one Inch.	Over one Inch.	Rainfall in Inches.	Under one Inch.	Over one Inch.	Total.	Rainfall in Inches.	Under one Inch.	Over one Inch.	Total.
April	·81	1	...	...	...	...	·40	·38	·13	·51	·73	·88	·76	·85
May	·55	3	...	22·33	2	3	4·69	1·13	·75	1·88	8·58	2·63	4·43	3·14
June	2·82	3	1	2·25	6	1	3·11	4·25	1·00	5·25	5·68	9·90	5·91	8·78
July	3·67	11	...	1·45	8	...	3·83	6·88	·88	7·76	7·00	16·04	5·20	12·97
August	3·69	7	1	3·15	12	...	4·69	6·75	1·25	8·00	8·58	15·73	7·39	13·38
September	2·10	3	1	5·92	8	2	6·27	5·00	2·13	7·13	11·47	11·65	12·60	11·92
October	3·34	3	2	9·87	10	2	11·73	7·00	4·00	11·00	21·45	16·32	23·66	18·39
November	3·74	4	2	17·20	7	6	14·73	7·00	5·00	12·00	26·94	16·32	29·58	20·07
December	·14	3	...	3·21	3	2	3·87	3·00	1·38	4·38	7·08	6·99	8·16	7·32
January	·02	1	...	·22	1	...	·19	·50	·13	·63	·34	1·16	·76	1·05
February	...	...	...	...	...	...	·96	·50	·25	·75	1·75	1·16	1·47	1·25
March	...	...	...	...	...	...	·19	·50	...	·50	·34	1·16	...	·83
Total ...	20·88	39	7	65·60	57	16	54·66	42·89	16·90	59·79	100	100	100	100

The rainfall as will be seen is very unevenly distributed, more than 50 per cent. of it falling between the middle of October and the middle of December; from the last mentioned time until June there is seldom much rain, unless it be of a cyclonic character: cyclones however are not unfrequent, and often visit this coast in May; during one which burst here in 1877 22·23 inches of rain were registered in 96 hours, 16·55 inches of which fell in one period of 24½ hours.

The temperature and state of the atmosphere varies very much with the time of year; during April, May, and June strong westerly winds commonly prevail, which are intensely hot and dry, withering up all vegetation and reducing the country generally to the appearance of a desert, in which operation the general want of trees, hedgerows and plantations greatly assists. Later in the year, after the burst of the south-west monsoon, occasional showers, commonly thunderstorms, render the air more and more moist until, before the change of wind to the north-east in October, the air becomes oppressive, and excessively damp; after the heavy rains at the latter end of the year the climate is cool and very favorable to agricultural operations; heavy dews invariably falling and so enabling the crops to perfect themselves. Were it not for the shortness of the season, and the uncertainty of the rainfall being fairly distributed, the climate would be very advantageous to agricultural pursuits; as it is, it presents many terrible obstacles in the way of the farmer; the weather in January and February however could not be excelled, usually, for harvesting operations.

The Farm Estate, which stands about twenty feet above the sea level, is a triangular block of land divided into two nearly equal portions by the waste water channel of the Mylapore tank running west and east. The portion lying south of the channel is alone referred to below, the other portion being intended for a stock farm, and will be most of it laid under grass; the former portion is divided into twenty fields and its area is occupied as follows:—

	ACRES.	ACRES.
Field No. 1	2·38	
Do. ,, 2	1·62	
Do. ,, 3	1·78	
Do. ,, 4	5·87	
Do. ,, 5	0·94	
Do. ,, 7	3·29	
Do. ,, 8	2·62	
Do. ,, 10	4·25	
Do. ,, 11	2·96	
Do. ,, 12	3·43	
Do. ,, 13	2·73	
Do. ,, 14	3·47	
Do. ,, 15	7·30	
Do. ,, 16	4·82	
Do. ,, 17	4·90	
Do. ,, 18	4·59	
Do. ,, 19	4·37	
Do. ,, 20	1·48	62·80
River-bed under cultivation		4·52
Fruit and fuel trees		32·56

		ACRES.	ACRES.
Farm-yard and buildings	.. ..	5·30	
Superintendent's and Overseer's houses.		2·23	
Slaughter-houses and ground	.. ..	3·97	11·50
Roads	.. ..	9·37	
Channels	.. ..	4·13	
Waste land, river-bed, &c.	.. ..	11·28	24·78
Agricultural College.	Site and grounds ..	19·94	
	Students' cottages ..	2·67	
	Botanical Gardens ..	5·20	27·81
		Total ..	163·97

The farm soils are all derived from alluvial deposits, probably estuarine, the characteristic silicious sands covering the greater part of its area, with beds of black clay below the surface at varying depths; the latter occasionally crop out. A ridge of metamorphic rocks runs through this portion of the farm in the direction of south-west to north-east, protruding in two or three places.

When the estate was originally taken up almost the entire surface was covered by a low dense pestiferous scrub of prickly-pear and wild guavas; there were no roads, and the existing wells were in a ruinous state, choked with rubbish, and most of them dry; whilst the land was broken up with old brick-yard pits and covered with the ruins and foundations of old buildings. The land was selected because it was in the hands of Government at the time, and the only available piece of land near Madras; it was also a nuisance to the neighboring town of Saidapet and for that purpose it was desirable that it should be cleared.

The farm was opened in April 1865, under the management of a committee of gentlemen, which existed until 1871, when it was dissolved and the present arrangements came into force. Before the year 1870, there is little matter of any value recorded in the reports. None of the land of the farm is irrigable by gravitation, but it contains about twenty acres which it is possible to bring under well irrigation. The water in the wells has to be raised generally about twenty feet. A considerable increase in this area will shortly take place, bringing, it is intended, as much as 40–50 acres under occasional irrigation, which will allow of more certainty being obtained in experimental cropping. There are at present two bucket pumps and two double mhotes, besides several other lifts of different kinds, in regular work.

The buildings, which consist of a granary, store-houses for ca ttle food, &c., a chaffing and cotton-ginning room, sheep sheds, cattle sheds, a poultry house and other necessary accommodation, are most of them built of brick-and-mud walls, excepting in the case of open sheds where the pillars are of brick and lime, and are covered in all except two cases with tiles; they are situated at the south-east extremity of the farm, and although not in the most advantageous position, are commodious and efficient. The Farm Overseer's quarters are adjacent to, and the Superintendent's near, the yard.

Since the establishment of the Agricultural College in connection with it, the objects of the farm have become two-fold—Educational and Experimental. For the former purpose, it is endeavored to carry on,

side by side with purely experimental work, the system of improved agricultural practice which experience has shown to be best adapted to this country, in order that the students may see and learn with their own eyes the results obtained. In experimental work the following objects are held in view :—

"(1.) To ascertain by experiment the proper use of rotation in crops in this country.
"(2.) To introduce the system of root or green-crops in lieu of fallow, without artificial irrigation.
"(3.) To introduce new crops.
"(4.) To provide new kinds of seed, and fresh seed for the crops now cultivated.
"(5.) To make experiments in the use of water for the cultivation of crops now termed "Dry" crops, and for raising grasses and other crops to be used as fodder.
"(6.) To make experiments in the use of lime and other manures—mineral and animal.
"(7.) To introduce new and improved implements of rural labor.
"(8.) To improve the working cattle, sheep, horses, and other varieties of live-stock in the country."

The soils of the farm vary from light blowing sands, through sandy loams of greater or less value, to a stiffish loam, but the area occupied by the latter class is only about 3 or 4 acres at the south-east corner, being Fields Nos. 1, 2, 3 referred to above. The fields which are of best quality in the farm are inferior to the land generally cultivated in the country, being very sandy and extremely deficient in organic matter—containing only about 2 per cent. of that substance—and are consequently very liable to the effects of drought, having little power of absorbing or retaining moisture. The worst soils of the farm, besides some that have already been planted with trees cover Fields Nos. 17, 18, and 19 ; in them, the sand is very coarse and almost pure silica. The most valuable portions are Fields Nos. 4, 8, 10, 11, 13, 14, and 15, the rest forming a series filling up the intermediate space. The following analyses, made some years ago before the soils had been ameliorated to any great exent by cultivation and manuring, give some idea of their natural poverty ; the soils referred to are some of the best on the farm :—

Constituents.	No. 4 Field (East side).		No. 1 Field Surface Soil.
	Surface Soil.	Sub-soil.	
	Per cent.	Per cent.	Per cent.
Alumina	4·420	2·060	3·240
Oxide of iron	1·800	2·900	1·350
Phosphate of lime	·240	·009	·120
Carbonate of do.	·700	·560	·310
Do. of magnesia	Trace.	Trace.	Trace.
Sulphate of lime	Do.	Do.	Do.
Chlorides	1·080	·720	·900
Moisture	2·760	1·420	2·090
Organic matter	2·500	1·740	2·120
Sand	85·900	90·400	89·870
Total ...	99·400	99·809	100·000

It is also well to record the values placed on the land in 1865 by the Revenue Settlement Department, which are embodied in the table below:—

No.	Irrigated or Dry.	Source of Irrigation.	Description of Soil.	Taram.	Rate per Acre.	Area.	Assessment.
					RS. A.	ACS. CTS.	RS. A.
1a	Dry ...	Government well.	Permanently improved...2 1	1	4 8	0 25	1 2
b	Do. ...	...	Black sand...5 1	5	1 8	4 21	6 5
2	Do. ...	...	Do. ...5 2	6	1 4	15 51	19 6
3	Do. ...	...	Red loam ...7 2	5	1 8	6 66	10 0
4	Do. ...	...	Do. ...7 2	5	1 8	1 94	2 15
5	Peramboke.	...	......	...	...	0 67	...
6	Dry ...	Government well.	Permanently improved...2 1	1	4 8	0 68	3 1
7	Do. ...	...	Black loam...4 2	4	2 0	0 75	1 8
8	Do. ...	Government well.	Red loam ...7 1	4	2 0	8 63	17 4
9	Do. ...	...	Red loam ...7 1	4	2 0	5 21	10 7
10	Peramboke.	...	......	...	...	5 18	...
11	Dry ...	Government well.	Permanently improved...2 1	1	4 8	3 90	17 9
12	Do. ..	...	Red loam ...7 1	4	2 0	4 11	8 4
13	Do. ...	...	Do. ...7 1	4	2 0	3 93	7 14
14	Do. ...	...	Black sand...5 2	6	1 4	3 99	5 0
15	Do. ...	...	Do. ...5 2	6	1 4	11 96	14 15
16	Do. ...	...	Black loam...4 2	4	2 0	5 59	11 3
17	Do. ...	...	Do. ...4 2	4	2 0	4 43	8 14
18	Do. ...	...	Black sand...5 2	6	1 4	7 19	9 0
19	Do. ...	...	Do. ...5 2	6	1 4	12 14	15 3
20	Do. ...	...	Red sand ...8 2	6	1 4	2 61	3 4
21	Do. ...	...	Do. ...8 2	6	1 4	1 47	1 13
22	Do. ...	...	Do. ...8 2	6	1 4	3 34	4 3
23	Do. ...	Government well.	Do. ...8 2	6	1 4	5 1	6 4
24	Do. ..	...	Do. ...8 2	6	...	3 79	4 12
25	Peramboke.	...	......	...	...	9 42	...
					Total ...	132 57	190 2

Abstract exhibiting the Area and Assessment of each Class of Soil.

Taram or Class.	Rate per Acre.	Area.	Assessment.
	RS. A.	ACS. CTS.	RS. A.
1	4 8	4 83	21 12
4	2 0	32 65	65 6
5	1 8	12 81	19 4
6	1 4	67 1	83 12
	Total ...	117 30	190 2
	Peramboke ...	15 27	...
	Grand Total ...	132 57	...

CHAPTER II.

THE TREATMENT OF THE LAND.

DEEP CULTIVATION.—Year by year experience of the results seen on this farm confirms the opinion, "that the value of deep culture can, for usefulness in India, be scarcely overrated." Shallow cultivation is the curse of Indian agriculture, and the man who can induce the ryot to add an extra inch or two to the depth of his arable land will be as much entitled to the gratitude of his country, as the man who makes two blades of grass to grow where only one grew before. The usual system of dry land management in this district, which allows of crop after crop being taken off the land without a particle of organic manure being used, and is content if the cultivation of the soil is confined to a surface-stirring of not over three inches in depth, is most suicidal. The great object of the cultivator of dry land should be to enable his soil to retain as much water as possible without its being stagnant or being actually visible to the eye. He should take care that no water remains on the surface of the land, and by deep ploughing and the liberal use of organic manures increase, as much as possible, the porosity of his soil; instead of this, the result of his operations is that his soil is rendered as little porous as possible; his lands during the rains are flooded and swampy, while during the dry weather they are baked and cracked.

In referring to deep cultivation deep ploughing is not at all necessarily referred to: *deep ploughing* signifies the inversion of the soil, *deep cultivation* only the deep stirring of it; the former is in many cases injurious, and must in no case be rashly attempted. On such soils, for instance, as those resting on a tenacious soapy subsoil, which in the process would be brought to the surface, *deep ploughing* would render the surface soil unproductive until physical and chemical agencies had again restored it to a condition fit for the growth of crops; and it would be equally as unwise to bring up to the surface, by working the plough more deeply, portions of a subsoil which is poorer than the surface soil, or that is otherwise calculated to injure the surface soil in its physical character: in some cases good land has been ruined for many years owing to a raw subsoil in which nothing would grow, being brought to the surface. *Deep cultivation* on the other hand has almost always most beneficial effects; it is not so much that the outturn is enhanced, but that the soil is not so easily affected by climatic disturbances, affording a larger field for the roots of plants to search for their food in, and thus maintaining the average productive power over a much longer period. Unless more manure is used, no extra depth of cultivation can permanently maintain an increased outturn; the two things must go together. Deep cultivation will always have more effect

on strong stiff soils than on light ones; the benefits accruing will also be clearly visible for a long period of years on the former class of soils, whilst on the latter they will be much more fleeting. It is extremely probable that deep cultivation can, if universally followed where possible and efficiently performed, do perhaps more to avert famine in this country than almost any thing else; it would also if adopted, greatly enhance the producing capacity of the land, as our surface soils cannot but be in a very reduced condition for the supply of the requisite food for our crops. There is reason to believe that the result which has followed the breaking of the sod of the western prairies of America—a wonderful change and amelioration of climate, together with an increased rainfall and less violent variations of temperature—would take place in India, were our arable lands more deeply cultivated, and thus rendered absorptive of the rain-water which now so often flows away to the sea. The analogy between Indian arable soils and the unbroken hard-beaten sod of the prairie is very close, in respect to their non-absorbent qualities, only differing in a slight degree. The fact that breaking up land reduces the flow of water off it is well known to tank-makers, and if the inefficient cultivation now practised has such effects, how much more might not real deep cultivation do?

During the drought of 1876 the advantages of deep cultivation on this farm were clearly shown; the most casual observer in looking over the crops could not have failed to note the remarkable superiority of the plants growing on the deeply tilled soil, compared with those growing on the head-lands of the fields and other shallow cultivated land. Without the aid of any irrigation water a crop of Sorghum saccharatum yielded 5,000 lb. of straw and 924 lb. of grain, per acre; while, crops of yellow cholum and Planter's friend yielded from 300 to 450 lb. of grain and 2,500 to 4,000 lb. of straw per acre, thus showing that by deep cultivation and good management in the driest seasons a fair supply of food for the people and fodder for the cattle of the country could be grown even on such inferior soils as those of the farm. The following table gives some figures showing the effects of deep and shallow cultivation; the deep cultivation being in the body of a field, the shallow on its headlands:—

During Growth.		Duration of Growth.	Nature of Cultivation.	Area of Plot.	Yield of Straw.	Yield of Straw per Acre.	Proportion.	Yield of Grain.	Yield of Grain per Acre.	Proportion.
Rain-fall.	Wet Days.									
				S. YDS.	LB.	LB.		LB.	LB.	
·16	3	87 days.	Deep..	16,027	11,456	3459·6	100	221	66·7	100
			Shallow.	2,180	216	479·5	14	4·5	9·99	15

The whole field had been heavily manured throughout, and if anything the head-lands received more than their share of the manure During the growth of this crop only ·16 inches of rain fell. The seed was sown after a week's dry weather, which followed a fall of 1·55 inches, before which there had been no rain at all for more than a fortnight.

The head-lands were cultivated fully as deeply and as well as is the ordinary practice of the country, which, there is therefore no room for doubt, intensifies enormously the occasional deficiencies of rainfall we suffer from.

Deep cultivation should be carried out by degrees, the subsoil plough should be freely brought into use, and, when an even texture and condition to a considerable depth has been gained, deep ploughing may be resorted to. The depth of cultivation most advantageous to a particular soil can only be found out by experiment.

IRRIGATION.—Although it has not been possible, from the absence of the necessary facilities for the purpose, to carry out any accurate experiments on this practice, much valuable experience in the use of water has been gained.

It is frequently remarked by persons, who ought to know better, "that, if the Indian ryot knows but little regarding dry-land cultivation, he has nothing to learn regarding wet-land culture." This is a most serious mistake, for, as far as is known the cultivation of irrigated land in this country is but little, if at all, superior to that of unirrigated land. To produce an average crop on a good soil, with the aid of an abundant supply of water, is no test of the quality of the farming practice; the question is whether this good soil could not, with half the quantity of water generally used, be made to produce as good results; in this way doubling the area under irrigation, and at the same time improving the sanitary condition of the country and maintaining the productive powers of the soil over a longer period.

We do not require to make our lands into swamps, to enable us to get good results from irrigation, unless, indeed, we wish to confine our practice to the culture of low types of agricultural plants. Merely pouring water into a paddy field, floored with an impervious subsoil, is not making the best use of irrigation. The water must pass through, and not merely into and over the soil. We want perfect filtration, by which the water will pass down through the soil, and away by subsoil drainage, either artificial or natural. Until we possess this, we cannot hope on ordinary wet land to grow high types of plants. Irrigation water, judiciously applied, enables a plant to utilize thoroughly the food in its neighborhood, not only by rendering that food more fit for assimilation, but by bringing it within reach of its roots.

Of the amount of water used by the ryot for growing paddy there is little doubt, that the volume varies from 8-12 feet in depth: in the Coimbatore District 12 feet deep is required; whilst in an experiment made in the Godavari District, carried out expressly to discover the amount generally used, a sheet of water, an acre in extent, and 9 feet deep, in addition to a rainfall of 26 inches, was taken to bring to maturity one acre of paddy, and this under the superintendence of Irrigation Officers, whose presence undoubtedly contributed to lessen the quantity of water that would otherwise have been used. There is no reason to suppose that the ryot in this case was more greedy in the use of the water than other ryots, who are equally favorably circumstanced for getting a supply. The quantity used in other irrigation experiments, made by the Public Works Department, varied from 6 feet to 7 feet in depth in addition to

the rainfall to mature a crop of paddy. Experience on the farm has proved that under moderately good cultivation, with a soil of fair average quality, a volume of water, about 4 feet in depth, is ample for the production of one crop of paddy. Not only does swamp irrigation cause an enormous waste of a valuable producing power, but it is highly prejudicial in many other ways; the health of the people is injured; the soil is rendered unfit for cultivation, except under semi-aquatic crops of low types; and the capabilities of our irrigation works are seriously lessened by the smaller area thus watered. No doubt irrigation water is partly used in such wasteful quantities in order to maintain the fertility of the land, which the ordinary practice of the ryot is the best method of destroying; there is no reason however why the fertilizing agent should be confined in its use to such small areas, for, if used economically, twice the area of land, even under paddy, might be irrigated, and for this plenty of manure could be obtained from other sources.

In irrigating lands under wells the ryot has learnt to be more careful of the water, but the area so irrigated is but an infinitesimal portion of the total arable area of the country.

DRAINAGE.—The unmerited ridicule with which the advice of a distinguished agriculturist was received some years ago in this Presidency, when he ventured to advise our ryots to drain their paddy fields, is well known. Speaking generally, that advice was perfectly sound, and there is not the least doubt but that, had it been generally adopted, the country would have been richer by some millions of rupees than it now is. Irrigation and drainage must proceed together; the vast expenditure the State has incurred on irrigation works will never produce a fair return, until the districts so watered are properly drained. The almost perfect irrigation arrangements of some districts, under present circumstances, act only to their injury. The command of an abundant supply of water throughout the year is the very reason why, in the neighborhood of some of our best irrigation works, there is now so much valuable land abandoned. If it is the duty of the State to provide its tenants with the means of irrigating the land they occupy, it is equally its duty to see that proper drainage arrangements are made, so that the irrigation water they provide, may not collect and stagnate in the soil to its injury, and to the injury of the health of the people who reside in the neighborhood of land so irrigated. But, while a large tract of country has thus been rendered unproductive by the abuse of irrigation in the absence of proper drainage, there is still in this Presidency a far wider area of country that is injured by natural means, through an excess of water from rainfall or other causes. Not only does such water on retentive soils greatly retard field operations at the season when such work yields the largest returns, but it also prevents the free use of improved field implements, rendering it impossible to adopt superior methods of cultivation, and confining the cropping of the land to the lower classes of plants. How frequently it now happens, during September and October, when it is so important that every hour should be utilized for getting in the cold weather crops, that a heavy fall of rain puts an entire stop for days to all field operations on our retentive soils, by making the land unfit to carry cattle and implements, until evaporation has again rendered them sufficiently firm for the cultivating operations to be proceeded with.

The great desire of the intelligent cultivator is to commence operations on his soil, as soon as possible after the rains first begin, and to get it cultivated and sown without loss of time, in order to secure the full advantage of the growing weather for starting his crops. On a good deal of the stiff land of this Presidency, nothing can be done in working the soil until a week or more after a heavy fall of rain, and frequently by the time that the land is in a state fit for being worked, the weather has undergone a complete change; the air having become dry, and the sky clear and cloudless; conditions, which are anything but favorable for the success of newly sown crops. On the other hand, similar land when properly drained will generally be fit within a day or two after heavy rain. Not only does an excess of water in a soil of a retentive character prevent the cultivators of such soils from taking full advantage of seasonable rains for getting in their crops, thus delaying and putting out of season all subsequent operations, but a large proportion of the seed sown under such conditions invariably perishes, and another considerable proportion yields only undersized sickly plants, while the plants produced by the remainder yield but very poor returns; from having so much to contend with during their growth from weeds, which owing to the wetness of the ground, cannot be regularly removed by the bullock or hand-hoe; from the absence of aëration in the surrounding soil, on account of the impossibility of working cultivators satisfactorily in a wet soil; from the attacks of insects, and from fungoid diseases, mildew, rust, &c., which delight to feed on crops that are growing under unfavorable conditions. During a drought, crops on undrained soils are far more likely to suffer from it than those on a similar soil that has been properly subsoil drained. At such a time undrained soils cake over, become hide-bound, and full of cracks, while drained soils are loose and friable, conditions suited for the absorption of dew and watery vapor during the night, while the whole body of the tilled soil being more or less porous, it holds water readily in mechanical suspension; and, as the roots of the plants growing on such a soil meet with no obstacle to their free passage, but rather encouragement to their growth, they naturally grow deeper into the soil, and are thus better protected from the hurtful influence of a scorching sun.

This much being certain, it was resolved to make some experiments in subsoil drainage. When this was first proposed, it was contended by some that, if water is so essential for the proper growth and development of field crops in Southern India, it would be exceedingly unwise to attempt to lessen the quantity of this element in our soils. It must be remembered however that no description of subsoil drains can remove from a soil the whole of the moisture it contains, nor any which could be of use to growing crops; there is always even in the most perfectly drained land a considerable quantity of water which no drainage can remove. It has been found again and again that a well-drained soil contains during a drought more moisture than an undrained soil of similar character and composition; there are many reasons why this is so; one is that drainage facilitates the working of a soil by field implements, not only in the greater perfection of the work done, but also in affording a longer season in which to do the work under favorable conditions, and as a thoroughly tilled soil is always well pulverised and therefore more porous, its capabilities to retain

water are greatly increased, as well as its ability to absorb moisture from the air. A proper seed-bed cannot be obtained in a soil in which there is too much water; for to cause the germination of seed and the healthy growth of plants, atmospheric air must be present in the soil, and it cannot be there in a sufficient quantity when the soil is full of water. Further, a water-logged soil is always cold, not only on account of the great reduction of temperature caused by the evaporation of its water, but also because heat cannot penetrate into it. Tropical plants suffer very much when the temperature of the soil on which they are growing becomes much reduced. There are, of course, soils that do not require to be artificially drained, being sufficiently well drained naturally; artificial drainage is only necessary for the removal of such water as the land will not hold in suspension, or that of springs found immediately under it.

Where, as in this neighborhood from 3 to 16 inches of rain sometimes fall in 24 hours, not more than one inch of which may sink directly into the ground, it will always be necessary to provide surface drains for carrying off flood-water even where the subsoil drainage is perfect.

Persons who are unacquainted with agriculture, as practised in this country, can form no idea of the enormous losses that the cultivators of badly-drained land suffer in an unusually wet season. The money expended in draining an acre of land would be soon recovered; indeed, on many soils in from 8 to 10 years, no doubt the entire cost, with interest on capital, would be repaid.

In this country deep cultivation is absolutely necessary in order to secure the full benefits that result from subsoil draining. A soil that is simply drained, the particles of which are not separated and loosened under the influences of thorough cultivation, cannot in a dry season be expected to take up much more moisture from the atmosphere, than undrained land of the same kind in a similar mechanical state. The absorption of moisture from the air can only occur in porous soils into which it can pass freely; sun-dried, hard, compact soils being quite incapable of absorbing moisture from the air. As in this country, at night, the air near the surface of the ground is at certain seasons so heavily charged with moisture, it is especially necessary, in order to secure this moisture, that our soils should be kept as open and as porous as possible.

Thus it is probable that the general introduction of subsoil draining must be deferred for a considerable length of time, but general drainage must be carried out by the State in many places soon, unless it is desired to aid the repetition of famine.

It has already been found that there are technical difficulties in this country which preclude the exact imitation of the practice followed in Europe. Cutting drains in such a manner as to get a proper bed for the pipes and to allow no room for their shifting can only be effected by skilled laborers with proper draining tools: but the Indian laborer has no inclination to use other tools for excavation than his time-honored mamotty and crowbar; and if he were really inclined to use the draining spade, in most cases he would not have the strength to wield it; moreover, the soil during the greater part of the year is seldom in such a state that it can be worked with the spade without the assistance of the crowbar or pickaxe. Considering

these peculiarities, it is evident that wide drains with roughly worked bottoms very often cannot be avoided: but this difficulty may be overcome by allowing the people engaged in cutting the trenches to work in their own way while excavating to about four-fifths of the intended depth, and making the remainder of the excavation by the use of special tools, in order to secure the narrowest cutting possible. In this way a solid bed for the drain pipe will generally be secured. To neutralise the bad effects resulting from wide and badly formed drains, the use of collars on the pipes would be of good service; but the application of collars causes another drawback; viz., that the pipes encased in collars are frequently not well connected, because their perfect juncture cannot be so well attained when covered by collars as when without them, and as the collars must be made wide to admit of their use over pipes, which are neither quite round nor straight, it follows that sand has easier access to the pipes encased in collars than to those without them. There is thus no other way left than to cover the ends of the collars with plastic clay; or to double the piping—a thing which is impossible from its costliness.

The first experiment made in subsoil drainage was commenced early in 1873 in a field of nearly four acres, in which the soil is a stiffish loam, and was then of a sour soapy character, resting on a subsoil of a similar nature, and had been almost quite unproductive during the five previous years. The land was formerly (before it became the property of Government) used for growing paddy, under the repeated cultivation of which it had become injured. When heavily seeded, there was generally a fair covering of plant up to the time the crop was about one-third grown, and the plants looked well as long as their roots were confined to the few inches of the healthy surface soil; but after this, when the roots got into the sour soil, there was little further growth, the plants became yellow and stunted, and gradually red from the attacks of the fungoid disease, "rust," and only an exceedingly small yield of inferior grain was obtained; it mattered not what crop was tried, the result was generally the same. One portion of the field was drained with stone drains, and another with pipe drains; each portion being separately provided with a main drain and an outfall. On both plots the parallel drains were 3½ feet deep, and the main drain 4 feet deep, while the distance between each parallel drain was 24 feet. A year after laying it was found that the stone drained plot had not been successfully treated: the discharge of water from the drains was never very great, and soon became exceedingly small; ultimately ceasing altogether. The drainage with pipes was at first most successful, and the land has been permanently ameliorated, and the qualities it possessed, inimical to plant growth, have been removed. In January 1878—just five years after the commencement of the experiment—the drains were all opened and found to be blocked with silt in nearly every case. This was probably due in great measure to the pipes not having been properly laid, and also to the fact that the cracks, produced in the dry seasons, though much smaller than those that appeared before the land was drained, being very large and reaching down many of them to the level of the pipes, would at the first heavy rain convey the water immediately to the pipes, the joints of which admitting the water at once, and, if it held any earthy matter in suspension, this would also enter; but if the pipes were not well connected or otherwise out of order, the

sand brought down by the force of the water would enter also, which once inside of the pipes would be deposited.

In another case a small piece of water logged soil, on which nothing could be induced to grow was subsoil drained, but owing to the circumstances of the case the drains did not get a fair chance of success, and the result was a failure.

Another experiment is at present being carried on the farm, but all that has yet been arrived at is that the question requires a long and patient inquiry before it can be finally solved. The cost of draining an acre of land 4 feet deep with drains 30 feet apart will be about as follows :—

	RS.	A.	P.
Cost of cutting parellel drains 467 yards.	7	4	0
Do. main drain 75 yards ..	1	8	0
Levelling drains, &c.	1	0	0
Cost of 1,400 2-inch pipes	12	8	0
Do. 225 4-inch do.	3	10	0
Carting do.	1	6	0
Laying pipes and filling trenches ..	1	8	0
Outlet and contingencies	1	12	0
Total ..	30	8	0

This estimate would apply to a loamy soil of tolerably even quality; the rent charge in such a case at 7¼ per cent. on capital would be Rupees 2-4-0 per acre.

ROTATIONS OF CROPS.—Undoubtedly many benefits result from the adoption of a stringent rotation in cropping; still these advantages may be purchased at too high a cost. In a well cultivated district which is not subjected to any great atmospheric changes, but where the seasons recur with clock-work regularity, and with perfect uniformity, it may be desirable to introduce a regular system of rotation. A properly arranged rotation of crops not only enables the farmer to make the best use of the plant food in his soil, but tends to conserve the fertility of it. One tribe of plants thrives and luxuriates upon food which may not only be useless, but even noxious to another; one delights in lime, another in phosphoric acid, a third in potash, and so on. Some plants have tap roots, some fibrous roots; some feed on the surface of the land, while others derive their sustenance from a lower stratum. Some plants are consumed by stock on the farm, and the excrements of the animals fed on them are again returned to the soil; while others are removed from the farm, none of the fertilizing matters they contain being returned to the soil. Some plants have narrow leaves and an upright habit of growth which encourages the growth of weeds; while others have broad leaves and put out lateral branches which shade the ground and check the growth of weeds. If a certain crop is cultivated year after year on the same piece of ground, it will ultimately remove such a quantity of the particular plant food it delights in as to render the raising of a remunerative crop of this particular plant a matter of great

difficulty. Granting that by careful manuring the elements of plant food taken up by a certain crop can be regularly returned to the soil, there are still many difficulties to contend against: it has been found that certain insects prey on particular crops, and that, if these crops are repeated too frequently, they increase to such an extent as to interfere very seriously with the profitable culture of these particular crops. Again some plants—many of the leguminous family for example—have large fleshy roots, in which they have stored up a large amount of nitrogenous substances, which they have elaborated from the ammoniacal matter they have absorbed; these roots, when left in the soil, decay, and afford a large quantity of excellent food for the following crop. This is well known in England where a good clover crop—a crop producing plenty of fleshy roots—is invariably followed by a good crop of wheat, and here the cereal crop taken after a gram crop is generally a good one. Though a large crop of gram removes a good deal of lime from the soil, it is nevertheless considered by farmers as a restorative crop, and the reason just given explains this apparent paradox.

Again it is the object of every agriculturist to economise labor, and, to do this efficiently, the seed-time must be extended over as long a period as possible. In temperate climates, the seed-time extends throughout nearly the whole year. Here owing to the character of the season, it is not possible to extend the seed-time very much; but to a certain extent it is, and, in constructing a rotation for any locality, the climate, having a most important part to play as regards the Labor Bill, must be carefully considered.

As a rotation for dry lands applicable to many soils; including amongst the crops suggested two of the most valuable products commonly grown in Southern India; providing an adequate supply of food for man and beast; not presenting a system of exhaustive culture, in too repeatedly growing the same crop or description of crop; and enabling the land to be kept free from weeds, the following may be suggested:—

1st year—Corn crop and cotton.
2nd ,, —Indigo.
3rd ,, —Corn crop followed by a catch crop of gram.
4th ,, —Guinea grass.
5th ,, — Do.

The only portions of the crops in such a rotation, which should actually be sold off the land, would be the cotton lint and indigo dye; the corn crop being used for the support of the cultivator, his family, and of such laborers as he employed, should not be lost, as the ordure and rubbish from their houses might be collected and returned to the land. The crop of guinea grass would take the place of "waste" under native management.

On stiff strong rich soils, instead of planting guinea grass in the fourth year, an early sown cholum crop, cut green for fodder, followed by a leguminous crop, such as black or green gram, could be taken and, being harvested in the early part of the year, might be succeeded by a summer crop of gingelly; in the fifth year indigo might again be taken, followed in the sixth year by a corn crop, in the seventh and eighth years by guinea grass. The rotation would then run as follows:—

1st year—Corn and cotton.
2nd ,, —Indigo.
3rd ,, —Corn followed by gram as a summer crop.
4th ,, —Cholum cut green, followed by a leguminous crop and by gingelly as a summer crop.
5th ,, —Indigo.
6th ,, —Cholum followed by gram as a catch crop.
7th and 8th years—Guinea grass.

Another variation might be made ; instead of indigo in the fifth year corn and cotton might be introduced, and another year added to the rotation, which would then become a nine-course one.

The farm being devoted exclusively to experimental work, no fixed rotation of crops has been adopted ; the general principles referred to above are always held in view, and there are at present two rotation experiments proceeding in which cases the rotations which will be followed as near as circumstances permit are :—in one case.

1878, 1st year—Maize and cotton (manured).
1879, 2nd ,, —Indigo (limed).
1880, 3rd ,, —Yellow cholum or sorghum.
1881, 4th ,, —Gingelly.
1882 5th ,, —Guinea grass (manured).
1883 6th Do.

and in the other

1878, 1st year—Castor oil and raggy.
1879, 2nd ,, —Maize and cotton (manured).
1880, 3rd ,, —Guinea grass.
1881, 4th ,, — Do.
1882, 5th ,, —Dholl and tenney (top-dressed).
1883, 6th ,, —Indigo (surface dressed with manure).

CHAPTER III.

MANURES AND MANURING.

MANURING is performed either to maintain or enhance the natural productive powers of a soil, and all substances which are applied as manures act either mechanically or chemically. It is well known that a crop extracts from the land on which it is grown certain mineral and nitrogenized matters which are required for its nutriment, and that, if these crops are permanently removed from the land, the amount of such substances contained in the produce will be taken away. The capacity of a soil for furnishing plant-food being limited, in the end, if cropping without returning to the soil any of the matters removed in the crop, as is usually practised on the unirrigated lands of this Presidency, be continued, exhaustion must ensue. It has been abundantly proved however by Messrs. Lawes and Gilbert, at Rothamstead, that, when a soil is left unmanured for some years and at the same time cropped, the productive power of it is brought so low that ultimate exhaustion may be deferred for a very great length of time. The soil thus, as it were, possesses a power of protecting itself to a limited extent from the rapacious greed of the cultivator, for though it may contain abundance of the elements necessary for the support of plant-life, these, being in a presently unavailable condition, are only yielded up in driblets as they become soluble. This fact also explains why the results of a chemical analysis are so often misleading, and accounts for results obtained in manuring which are otherwise altogether inexplicable.

In applying manures the nature of the soil being dealt with must be considered, for it is often great folly to apply manures in quantities and methods to light soils, which amounts and system of application would be the best in the case of strong deep soils. In India with its burning sun and terrific heat the gradual dissipation from the soil of the organic matters it contains must be very great, and, knowing the importance of the presence of these matters, every effort should be mode to conserve and increase them.

Some manures act both by adding to the plant-food of the soil and by improving its mechanical condition, amongst such may be mentioned farm-yard manure, composts, lime, burnt clay, &c.; other manures again are simply mechanical in their action, as for instance sand when applied to a clay; the last great class of fertilizing substances is that which contributes only to the increase of those substances which the plant requires for its growth. Manures may be applied with a view to their present or ultimate effect; for instance a top-dressing of saltpetre might be given to a cereal crop which was not looking healthy with a view to stimulate its growth, but bones would be used as a dressing to add to the material condition of the soil. Some crops again prefer a rich upper layer of soil,

others seek for all their food deep in the soil; for the latter, manure must be applied before sowing and covered in, for the former top-dressing will probably be as efficacious a manner of manuring as possible.

MANURES.—Before proceeding to describe the experiments which have been made, a few notes regarding the chief general and special manures which have been and are generally used will be appropriate. On the sandy soils, which cover the greater part of the farm area, organic manure is the chief want, for, although they are chemically poor, their physical condition is even worse.

FARM-YARD MANURE.—To provide sufficient quantities of such manure reliance is chiefly placed on the manufacture of it on the farm by housing all the cattle stock in loose boxes, where they and the manure are protected alike from sun and rain. The manure thus made consists of the straw used as bedding, and of both the solid and the liquid excrementitious matters of the cattle, which being allowed to accumulate in the boxes during two or three months, layer by layer, and being constantly subjected to the pressure of the animals' feet, becomes a rich homogeneous mass of a dark brown color, fitted at once for use, without undergoing any preparatory process. As the cattle stalled in these boxes are all fed, in addition to green fodder, on oil-cake, the manure is necessarily rich in the more important elements of plant-food, phosphoric acid, ammonia, potash, &c., as it is known that unless animals are young and growing nearly all the ash constituents and nine-tenths of the nitrogen contained in their food passes into the manure. It has been found that in an average year 20 cart-loads of this manure are obtained per head of working bullocks housed in these boxes; this is only the manure made at night and during a portion of the day when the cattle are not engaged in field labor; thus, for every pair of working cattle employed if their boxes be always well littered 40 cart-loads per annum of box manure can be calculated on.

The manure is now always used direct from the boxes; formerly it was carefully stacked in pits in the different fields in which it would be needed, but it was found necessary to give this up, as the manure in a dry season suffered so much, not perhaps by any diminution in its fertilizing ingredients, but in its physical properties; it became a fine powdery substance, very portable and easy of distribution but altogether destitute of the valuable physical properties of farm-yard manure. It must be remembered that the beneficial results attending the use of farm-yard manure are due to no inconsiderable extent to its physical action on the soil, as well as to its power of yielding to the soil the exact chemical food needed for the production of crops.

Though in the present day, box-feeding will not be adopted in this country for the same object as in Europe; still, there can be no reason why working, milch, and young cattle should not be kept in loose boxes at night. If we are to grow cotton, maize, &c., we must have manure, and there is no better or more economical way of making it than under the loose-box system. On sanitary grounds alone, the system is worth general adoption. At first sight it may appear objectionable to keep the animals for three or four months in the boxes, without removing

the manure ; however, no bad results arise from the practice ; the working cattle have for 10 years been always housed on this system, and the fear at first expressed that it would injure their hoofs has proved to be utterly groundless ; considerable numbers of cattle have been fattened also in loose boxes, and in no case did any of the animals have a single day's illness, though in several instances, the manure was not removed for upwards of three months, whilst it had accumulated nearly two feet in depth. Of course the excrements are not allowed to collect on the surface, the usual plan being with feeding cattle for the cattle-feeder to enter the boxes three or four times a day and to throw up the bedding with a fork. No smell whatever is perceptible, and there is nothing that the most fastidious person could object to : indeed, in this respect it is much cleaner than the usual system, which allows the solid and liquid excrements to lie and decompose upon the surface of the ground. In the loose-box system the products of decomposition as well as the liquid matters are absorbed by the litter. Loose-box feeding, which has done so much for the agriculture of England, can, there is no doubt, do much for the agriculture of India.

GREEN MANURING—Horse-gram (*Dolichos uniflorus*) is well suited for culture on sandy soils, for ploughing-in as a green manure.

The action of green manuring is two fold :—

1*stly.*—The substance of the plant decaying in the soil leaves behind a large quanity of prepared food, ready for absorption by the roots of the succeeding crop ; and

2*ndly.*—When ploughed in the structures of the green crop add directly to the amount of organic matters in the soil, and thus improving its mechanical condition, adding to its power of absorbing and retaining moisture, and increasing in the case of stiff soils their friability.

Leguminous crops ploughed in green are an especially good preparation for cereals, owing to the very high percentage of nitrogenized substances which they always contain.

In the neighborhood around Madras "summer crops" on dry sandy land are exceedingly precarious; on the average we have not more than one year in four in which crops sown in June or July yield returns that repay the expenses of cultivation; so that, instead of attempting to grow "summer crops" such as gingelly, cumboo, &c., except on a small scale on choice land, the wisest course after removing the "cold weather crop," would be, to clean the soil thoroughly, and then to sow it with horse-gram for ploughing-in. These sowings would in three months, or less, yield per acre from 2,000 to 3,000 pounds of plant which if ploughed-in would prepare the soil admirably for the succeeding "cold weather crops."

When the seed is drilled in lines, the land can be hoed by cattle or by hand during the growth of the crop; in this way the weeds can be kept down, and the soil maintained in a loose friable condition.

COTTON SEED when steeped to destroy its vitality is undoubtedly one of the best manures we possess, and is suited for any crop we grow, more especially the cotton crop. In cotton seed there is large quantity

of fertilizing matter concentrated in a very small bulk; it is thus well suited for coffee or tea planters, and where, in order to reduce the cost of transit, it is necessary to get a portable concentrated manure. Though at first sight it may appear rather a wasteful practice to use cotton seed as a manure, especially as the oil it contains, though valuable in feeding, is worthless as manure, it is nevertheless a practice to be recommended until some cheap and effective means of removing the outer husk of the the seed has been discovered. Cotton seed is used to some extent as a cattle food; but it is not a safe food to give, except in very small quantities and along with succulent fodder, as the cotton, which invariably adheres to the seed, sometimes collects in balls in the stomach, and produces serious and often fatal disarrangements in the digestive organs.

CASTOR CAKE has been generally used as a top-dressing after being first pulverized, and is applied at the rate of 200–1,000 lb. per acre. It is used on both unirrigated and irrigated crops. On the latter the result is in most instances very satisfactory, but on the dry crops little effect is noticed; however little else can be expected as it probably remains long inert in the dry land, though still available as plant food when favorable conditions arise. The cake is especially rich in nitrogen; it is therefore a powerful fertilizer; its action is slow; but, when mixed with cattle manure, it becomes a great deal more active and more fitted to meet the wants of quick-growing crops.

BASSIA NUT CAKE, called in Tamil Illupu, is obtained from the seeds of the *Bassia longifolia*, a tree which emits a disagreeable smell, when flowering resembling that met on entering a filthy stable; applied at the beginning of the rains, the manure is slow acting but useful.

The following are analyses of the three above mentioned substances:—

—	Cotton Seed.	Castor Cake.	Bassia Nut Cake.
	PER CENT.	PER CENT.	PER CENT.
Moisture	9·51	9·95	13·54
Organic matter	86·46	81·07	80·79
Ash .. { Phosphate of lime and magnesia..	1·71	4·49	1·43
Ash .. { Alkaline salts	1·77	1·80	3·63
Ash .. { Sand	·55	2·69	·61
	100·00	100·00	100·00
Containing nitrogen	..	8·69	2·73
Do. phosphoric acid	..	0·06	..

SLAUGHTER-HOUSE REFUSE.—This is obtained from the Commissariat slaughter-yards which are situated on the farm; it consists of blood, the solid refuse matters, and a considerable quantity of yard washings; the whole being removed daily to compost heaps. These are formed of ashes, burnt earth, weeds and other vegetable refuse, and the blood, &c., is poured over, the heap being covered each time with ashes

to prevent any offensive smell being given off. These compost heaps are placed in pits excavated for the purpose, made to hold from 50 to 80 loads. After the proper depth has been reached, generally from four to five feet, the whole is allowed to stand for two or three months, and then when opened the manure is found to be in the best possible condition for immediate use, having quite lost all its former unpleasant properties, and assumed a condition in which it is impossible to determine of what it was originally composed. In this state even caste coolies make no objection to work amongst it. The manure thus prepared is very valuable for all kinds of crops, especially for such as sugarcane, maize, &c., which require highly nitrogenized manures. For grass and fodder crops it is also of great value, and being of very fine texture is more useful in the dry season than farm-yard manure, which tends to open the soil to which it is applied.

VILLAGE NIGHT SOIL.—For several years a large quantity of poudrette was made, the excreta being collected in the Wudder settlement, which was formerly situated on the farm. Latrines were provided for the use of the people and a scavenger was employed to collect and remove the solid excreta. At the place set apart for the purpose the excreta was, as it was gathered, thrown into a heap, and the whole covered each time with a slight coating of ashes to prevent any offensive smell. When the heap had accumulated to about 20 or 25 cart loads, it was finally covered with ashes and soil, and a fresh heap begun. After lying in the heap for about eight or nine months, the night-soil was found to be quite deodorized and fit for use. In this state the coolies made no objection whatever to work with it; indeed, the character of the manure is so thoroughly changed, that few persons could, from its appearance alone, determine the nature of its original ingredients.

ALLUVIAL EARTH.—Large quantities of this valuable substance have from time to time been raised from a deposit which underlies a great portion of the farm. When raised it comes out in blocks, but after full exposure for six months it crumbles down to a fine powder, in which condition it makes an excellent surface-dressing for our sandy soils; not only does such a dressing greatly improve their physical state, but it also considerably increases their fertility by supplying the food needed by crops.

ASHES.—Large quantities of ashes from brick-yards, houses, &c., have been used with fair results, but the soils of the farm are more benefited by organic than by mineral manures. In one case a sample of ashes, which was said to be obtained from a brick-kiln, was found to contain 6 per cent. of moisture; 20·60 per cent. of the sample was soluble in hydrochloric acid, of which 3 per cent. was soluble in water; of the 80 per cent., insoluble in hydrochloric acid, 10·37 per cent. was soluble in boiling caustic potash; of the remainder, more than 60 per cent. consisted of sand and charcoal. In the portion soluble in hydrochloric acid, was no less than 3·874 per cent. of phosphoric acid and a fair percentage of potash, lime and soda.

The fuel used in the kilns is chiefly wood, but this could not possibly account for the large quantity of phosphoric acid found. It is customary to use a small quantity of dried cow-dung fuel, when the kilns are first lighted, but the quantity used is quite insufficient to account for the large percentage of phosphoric acid. The only possible explanation is, that, probably, the contractor who supplied the ashes to the farm, obtained a portion of them in some "Burning ground," instead of, from brick-kilns, as stated by him.

LIME (*Calcium carbonate*).—The use of this mineral as a manure in native agriculture is totally overlooked, and perhaps fortunately so; for if the ryot knew the stimulating qualities of a dressing of lime on the soil, he would soon deprive it of the small reserves of plant-food it contains, and leave it utterly barren. The mineral is easily obtainable in many localities and might be applied to some soils with great advantage, but it is not to be recommended for use except under enlightened management, for it has long been said of lime that "it enriches the father and impoverishes the son," in this referring to the use of it in excess. As a manure for leguminous crops it is very valuable.

It is obtainable here in the form of burnt shells (marine and fresh water), such as are used for preparing shell chunam in the Madras District; they yield an almost pure carbonate of lime, containing an exceedingly small quantity of impurities. After being slacked it forms a light powder, which can, with great facility, be spread over the land. But at the rate prevalent in Madras this is a costly way of obtaining lime for agricultural purposes. The cost is at least 50 per cent. in excess of the cost of equally good lime in the agricultural districts at home.

The high price of fuel is the great bar to the use of the mineral as manure; but, where near large towns considerable accumulations of organic refuse, consisting of sweepings, &c., exist, there appears to be no reason why limestone should not be burnt for agricultural purposes at a very low cost, as these accumulations would provide excellent fuel for the purpose, while the ashes made would of themselves make a valuable manure. Nodular limestone can in most instances be obtained at very easy distances, the position of the town of Madras being especially favored in this respect.

The following are the analyses of three sorts of limestone found in this Presidency:—

—	Limestone from		
	Vellicherry.	Poontoor.	Cuddapah.
Calcium carbonate	70·0	75·4	76·90
Moisture	1·2	2·0	2·85
Clay, sand and other substances insoluble in hydrochloric acid.	28·8	22·6	20·25
	100·0	100·0	100·00

CALCIUM SULPHATE OR GYPSUM.—Sulphate of lime, the refuse of the soda-water manufactories, has also been used with considerable success. This can be delivered at the farm at about 1 rupee per load. It is not chemically pure calcium sulphate; as, it contains besides calcium carbonate, various chlorides, sulphates and sulphurets of calcium and sodium; but on this account it is none the less valuable as a manure, while to us near Madras it is far less costly than the natural sulphate. Our soils being very poor in lime, this manure is of great value to them, but its special value is as manure for leguminous crops. As a constituent of compost heaps containing decomposing nitrogenised matters, it is of special value in arresting the escape of volatile ammonia, the sulphuric acid it contains having evidently a stronger affinity for ammonia than for the lime with which it is in combination.

Natural Gypsum has also been tried, but it has to be brought a considerable distance, and costs nearly 20 rupees a ton at the farm.

PHOSPHO-GUANO.—Small supplies of this valuable manure have been purchased at various times for use in our field experiments. This manure has been long and favorably known in England and in Germany. Its high fertilising qualities have again and again been noticed by Liebig, Voelcker, and others. The manure contains, in round numbers, about 39 per cent. of soluble phosphate of lime, about 6 per cent. of insoluble phosphates, nearly 4 per cent. of ready-formed ammonia, as non-volatile ammonia salts, and some potash. It has been ascertained that the manure is very efficacious as an application for preventing sugar-cane cuttings from being attacked by white-ants, and it must be remembered, it at the same time affords the food needed by the sugar-cane during its growth.

BONE DUST consists of minutely pulverised bones; so prepared in order to facilitate distribution over the surface of the land. This minute state of division is not generally necessary, and the dishonest dealer can, with much more ease, adulterate bone dust than he can adulterate bones which are simply broken; while for all practical purposes quarter or half inch bone is equally as effective, not perhaps in the immediate result, but in the general effect. All the different preparations of bones are valuable to the farmer, whether as boiled bones, crushed bones, bone dust, bone black, or in the form of superphosphate, chiefly in yielding calcium phosphate, though in the raw state bones yield a large percentage of ammonia, still it is as a means of adding phosphoric acid to the soil that they are chiefly employed by the farmer, as it is phosphoric acid that all cultivated crops appropriate so largely, and not only crops, but every animal the farmer rears removes from the soil large quantities of phosphoric acid in building up its internal framework of bones, muscles, &c. Assuming that the bones of an average sized country bullock weigh 80 lb. containing 55 per cent. of calcium phosphate, and an average sized sheep or goat 15 lb. of bones, containing a similar percentage, it is not difficult to explain in what way the soils of the ryot, on which stock are reared fast become exhausted in phosphates or bone material. Bones are costly in this part

of India, and their collection a matter of difficulty; but assuming that the annual death-rate of live-stock to be 10 per cent., nearly 19 thousand tons of calcium phosphate annually disappears; this would provide enough phosphoric acid for a million tons of our chief food-grains.

ANIMAL OR BONE CHARCOAL has been used several times. It is a very inert, slow acting substance, and though of value, as it contains a large percentage of phosphoric acid, immediate results can never be hoped for from its use.

SALTPETRE.—Potassium nitrate has from time to time been largely used; it is easily obtainable in many districts of the Presidency, in a state fit for use at a reasonable price. It is a good manure for cereals generally, but is most effective when employed on soils already in good manural condition, or when used as an auxiliary manure along with some organic substance. It has been used sometimes with great success, but at other times with little.

EXPERIMENTS.—Proceeding now to the experiments which have been made, it must be remembered that those referred to do not form a tithe of those which have been made, the results of which have not from various causes been fit for report, or have not been considered worth repetition here.

In 1872, a portion of a field planted with maize and Hinginghaut cotton was divided into plots each containing 2,500 square yards, and the top-dressings given in the table below applied to the Maize crop with the results mentioned; in the calculation half the gross area of each plot is deducted as having been occupied by the cotton crop:—

No. of Plot.	Top-dressings applied per Acre.	Produce.				Increase Per Acre.	
		Per Plot.		Per Acre.			
		Cobs.	Straw.	Cobs.	Straw.	Cobs.	Straw.
		lb.	lb.	lb.	lb.	lb.	lb.
3	None	150	588	580·4	2,276	..	...
1	Lime 968 lb.	219	1,008	847·9	3,902	267·5	1,626
2	Animal charcoal 484 lb. ...	160	806	619·5	3,120	39·1	844
4	Gypsum 968 lb.	178	724	689·2	2,803	108·8	527

Besides the top-dressings, the whole of the land was manured with farm-yard manure at the rate of about 8 tons per acre. It will be seen that the dressing of lime produced 267·5 lb. of cobs, and 1,626 lb. of straw per acre more than the plot simply manured with farm-yard manure; in this instance the cost of the lime was repaid by the crop to which it was applied, while there is not the least doubt but that the beneficial effects of this dressing were working for several years on the crops afterwards grown on this land. In these experiments gypsum was not so effective as lime, though it is a well known fact that this

substance is of especial value as a manure for the maize crop; probably, the superior efficacy of the carbonate over the sulphate in this instance may be due to the action of the former on such a soil (a stiffish one in a sour condition) as that on which these experiments were conducted in restoring a healthy condition, and in rendering insoluble silicates soluble and fit for assimilation by the growing crops. The inefficiency of the charcoal in these experiments is the action usually noticed.

Another set of experiments of a similar nature was made on a yellow cholum crop, on plots each measuring 1,000 square yards. The soil on which these experiments were conducted is stiffer than the majority of our soils. The top-dressings were applied at about the end of the second week in October, and, though doubtless a large proportion of the more soluble portions were washed off the land by the heavy rains which fell about that time, the results were more satisfactory than those of top-dressings applied ten days later, when the heavy rains had ceased.

No. of Plots.	Top-dressings applied per Acre.	Produce.				Increase Per Acre.	
		Per Plot.		Per Acre.			
		Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
		lb.	lb.	lb.	lb.	lb.	lb.
3 + 7	Unmanured	76	1,442	183·9	3,489	...	...
1 + 5	Lime 1,742 lb.	90	1,487	217·8	3,598	33·9	109
2 + 6	Saltpetre 242 lb.	131	1,633	317·0	3,951	133·1	462
4 + 8	Gypsum 1,742 lb.	97	1,435	234·7	3,472	50·8	– 17

It will be seen that the two plots dressed with saltpetre produced nearly twice as much grain as the two plots of similar size that were not manured, while they also produced nearly one-fourth of a ton more straw; as the cost of the saltpetre applied was under 5 rupees per acre, it was more than recovered in the increase obtained. The increase from lime was not quite equal to the cost of the applications; but this was scarcely to be expected, as the action of lime is much slower, though more durable than the more active saline manures. The benefit from saltpetre will generally be obtained during the year in which it is applied, or at the outside in very dry seasons within the second year, whereas lime may act and give good results for ten years.

Another experiment, made in 1870, of a similar nature gave very interesting results. The crop selected was Sorghum or Chinese sugar-cane; it had been sown on the 10th October in drills two feet apart with seed at the rate of 14 lb. per acre; the plants came up slowly but with regularity, and the manure was sown when they were about 4 inches high on plots, measuring $\frac{1}{18}$ of an acre each, in duplicate: as usual after sowing the top-dressings a bullock-hoeing was given. The following are the results :—

Manure applied per Plot.	Value.	Yield per Plot. Grain.	Yield per Plot. Straw.	Increase per Plot. Grain.	Increase per Plot. Straw.	Increase per Acre. Grain.	Increase per Acre. Straw.	Value of Increase per Acre.	Profit per Acre.
	RS.	LB.	LB.	LB.	LB.	LB.	LB.	RS. A. P.	RS. A. P.
Unmanured	...	60	908	...	...	...	...	...	...
13 lb. of Peruvian guano.	1	90	1,064	30	156	540	2,808	24 4 3	6 4 3
152 „ of lime	1	99	1,237	39	329	702	5,922	36 9 10	18 9 10
10 „ of saltpetre ...	1	110	1,318	50	410	900	7,380	46 7 6	28 7 6
37 „ of bone dust ...	1	108	1,328	48	420	864	7,560	45 8 3	27 8 3
112 „ of gypsum ...	1	96	1,181	36	173	648	4,914	32 9 1	14 9 1

In the above calculations the straw was valued at 5 rupees per ton, a low price; and the grain at the rate of 30 lb. per rupee, also a very low price.

It will be seen that saltpetre gave the best results; an expenditure of 18 rupees per acre on this manure having not only nearly doubled the crop, but, after repaying its own cost, left an additional farmer's profit of nearly 30 rupees per acre. The value of saltpetre has long been recognized in England; but its great cost in that country has prevented its general use; this salt is best applied as a top-dressing when the crop is a few inches above the ground: 100 lb. or at most 150 lb. per acre is enough to apply: it should always be mixed with sand or some similar material, in order that it may be more regularly distributed over the ground.

Bone dust stands second in the list; probably, if the continued effects of each were considered, it would stand first. Next comes lime (*chunam*); the expenditure of 18 rupees per acre was not only repaid by the increase in the crop, but a profit of nearly 20 rupees was added. Sulphate of lime (gypsum) comes next; this also not only repaid its original cost, but left an additional profit of nearly 15 rupees per acre. The guano repaid its cost, but only left a profit of about 6 rupees per acre; it was inferior; still there were probably other reasons for the comparatively small return it gave.

In 1871 a portion of a field planted in alternate lines with New Orleans cotton and maize was top-dressed in the latter part of the first week in October, the crop at the time being only a few inches above ground. The land set apart for these experiments was divided into 16 plots, each containing one-twelfth of an acre. The experiments were repeated in duplicate. The whole of the land had been manured before the crop was sown with farm-yard manure at the rate of 20 cart loads, or about 8 tons per acre. The following results are the averages of each pair of experimental plots over the two years during which the crop was kept down. The value of the top-dressings was Rupees 18 per acre :—

Manure and Top-dressing per Acre.	Average Yield per Plot.				Yield per Acre.				Increase per Acre.		
	First Year.			Second Year.	First Year.			Second Year.	Cotton in Seed.	Maize.	
	Cotton in Seed.	Maize.		Cotton in Seed.	Cotton in Seed.	Maize.		Cotton in Seed.			
		Cobs.	Straw.			Cobs.	Straw.			Cobs.	Straw.
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
8 tons of farm-yard manure only	50·5	94	206	22·5	611·5	1134·9	2,492	272·2	...	...	...
8 do. do. and 242 lb. guano	52·5	179	415	31·2	635·2	2165·9	5,021	377·5	129·0	1031·0	2,529
8 do. do. and 363 ,, saltpetre	55·5	147·5	365	29	671·5	1784	4,384	350·1	137·9	649·1	1,892
8 do. do. and 605 ,, bone dust	52·3	161·5	345	26·6	632·8	1954·6	4,180	321·8	70·9	819·7	1,688
8 do. do. and 605 ,, animal charcoal ...	66·1	126	244	25	678·8	1524·6	2,968	302·5	97·6	389·7	476
8 do. do. and 2,758 ,, gypsum	52·5	122	270	27·8	635·5	1476·6	3,280	336·3	88·1	341·7	788
8 do. do. and 2,420 ,, bassia nut cake ...	60·	177	315	26·8	726	2141·9	3,820	324·2	166·5	1007·0	1,328
8 do. do. and 2,758 ,, lime	53·6	124·5	299	29·1	648·5	1506·4	3,628	352·1	116·9	371·5	1,136

With the idea that by mixing bone charcoal with decaying organic matters some portion of its constituents might be rendered soluble by the action of the acids and heat generated in process of decomposition, several experiments, the results of which are recorded below, were made during the season of 1877. It is however difficult to say whether the increase, which is shown to be obtained by use of cake and bone charcoal mixed sometime before application is due to the partial decomposition of the cake or to any dissolution of the constituents of the charcoal; this point will require further examination.

1	Crop.	Yellow Cholum.		Planter's Friend.		Maize.		Sumba Paddy.	
2	Manure per Acre ...	330 lb. Bone charcoal. 380 lb. Cake. Freshly mixed.	330 lb. Bone charcoal. 380 lb. Cake. Mixed and allowed to decompose.	372 lb. Bone charcoal. 426 lb. Cake. Freshly mixed.	372 lb. Bone charcoal. 426 lb. Cake. Mixed and allowed to decompose.	372 lb. Bone charcoal. 426 lb. Cake. Freshly mixed.	372 lb. Bone charcoal. 426 lb. Cake. Mixed and allowed to decompose.	1,333 lb. fresh Cake.	599 lb Bone charcoal. 734 lb. Cake. Mixed and allowed to decompose.
3	Area of Plots in Acres ...	·655	·655	·16	·16	·16	·16	·3	·3
4	Yield per Plot. Straw.	LB. 3,517	LB. 3,685	LB. 2,760	LB. 3,058	LB. 506	LB. 408	LB. 1,145	LB. 1,337
5	Yield per Plot. Grain.	10½	10¾	25½	23	296*	236*	267	227
6	Yield per Acre. Straw.	5,369	5,626	16,500	18,348	3,036	2,448	3,816	4,456
7	Yield per Acre. Grain.	16	16	115	138	1,776*	1,416*	896	756

The yellow cholum crop was sown on October 4th, 1877, and the manure was applied when the crop was about 6 inches high on the 16th of the same month; it was harvested on 11th January 1878, having been on the ground 99 days, during which 30·13 inches of rain fell in 29 days, of which 29·27 inches in 27 days were registered after the application of the manure; the soil of the field is for the most part a light sandy loam but, being rather steeply inclined, is exposed to considerable surface wash. The planter's friend crop is referred to below where all particulars regarding the crop are given. The maize crop was sown in a field only recently levelled, and the results obtained in it are therefore open to great doubt owing to the uneven quality of soil; they are further in a measure vitiated as regards the weight of cobs obtained by the number stolen from the field before harvest. The crop was sown on September 24th and was 89 days on the ground. The manure was applied on October 14th and out of the total rainfall of 32·22 inches in 34 days, which the crop received, 29·47 inches fell in 28 days after that date.

The following experiment was made to test the value of poudrette; two plots each half acre in extent, of poor light sandy soil were selected and sown with yellow cholum on 14th October 1875; the plants appeared above ground in 5 days, and during the growth of the crop it was once bullock and once hand-hoed; the duration of growth was 115 days, during

* Cobs.

which time 21·29 inches of rain fell in 26 days; the poudrette was applied at the rate of 40 loads per acre; the results were as follow :—

	Yield of	Per Plot.	Per Acre.
		LB.	LB.
Unmanured ...	Straw ...	2,198	4,396
	Grain ...	193	386
Manured	Straw ...	3,108	6,216
	Grain ...	186	372

It is possible that the heavy dressing of manure killed a number of young seedlings from the solubility of the salts it contained. It must also be remembered that the poudrette did not contain any liquid excreta, which contain $\frac{5}{6}$ of the valuable portion of human excrements.

An experiment was made in 1876 to test the comparative value of box-manure, and the ashes which are left on burning cow-dung bratties. The crop selected was one of yellow cholum sown on 8th April on a sandy loam, cultivated under occasional irrigation for fodder. The experiment was stopped after the second cutting had been removed, owing to some alterations in the arrangements of the field. The results were that the first cutting of fodder obtained from the plot manured with the ashes, was heavier than that which was obtained from the plot manured with farm-yard manure; but, the second crop, was 50 per cent. lighter on the ash-manured land than that on the land manured with farm-yard manure.

Besides being incomplete from being stopped before completion, the fact that the crop was irrigated was such as to require detailed investigation as to the amount of water required by the different plots, organic manure being a well known economiser of water. The quick action of ashes is not surprising; it only agrees with the experiences of coffee planters and others who, in clearing a forest, burn off the timber, &c.

In 1877 several experiments were made with saltpetre as a top-dressing in different amounts, with a view to determine the most profitable rate at which to apply it, but, owing to the character of the season, these were not satisfactory; in the following table however the results obtained with a crop of Sorghum are given :—

		Unmanured.	60 lb. Saltpetre per Acre.	90 lb. Saltpetre per Acre.	120 lb. Saltpetre per Acre.
		LB.	LB.	LB.	LB.
Per plot ...	Straw ...	4,437	4,364	4,514	5,296
	Grain ...	167	208	490	160
Per acre ...	Straw ...	8,874	8,728	9,028	10,592
	Grain ...	334	416	980	320
		RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
Value of produce per acre ...		42 15 0	42 3 2	45 4 8	48 1 8

The crop was sown rather late but came up extremely well. The land had been manured by ploughing in a crop of horse-gram, but no great depth of cultivation was attained. The soil is rather light and sandy, and on that account not likely to give great returns from the use of saltpetre. The weather also after the application of the top-dressings was not at all advantageous, for, after December 11th, the date on which they were applied, only ·51 inch of rain fell during the remaining period of the growth of the crop, an amount perfectly inadequate to bring out the full action of saltpetre.

In the same year a field of "Planter's friend" was selected for a series of top-dressing experiments; it had been sown on September 28th with seed by the drill at the rate of 22 lb. per acre, and the crop came up well; during the period of growth (106 days) 30·65 inches of rain fell on 32 days. On October 12th in the centre portion of the field 24 plots each of $\frac{1}{12}$ acre in area were marked down, 12 on the western and 12 on the eastern side; those on the east were denominated Series B, and in the first few plots a very sandy description of soil, differing greatly from the rest of the field, prevails, this is at the southern end. The soil on which the A series were situated is of far more even quality, and it is from them rather that reliable information can be derived. The top-dressings were all applied on the same day and immediately afterwards the bullock-hoes were put into the field in order to mix the manures with the soil and prevent their being washed away by any showers; on October 14th there was a slight fall of rain, ·2 inch, which was probably of great value in dissolving, whilst at the same time it did not wash out the soluble manures; thus for the saltpetre and common salt applied the circumstances were as favorable as could be wished, but for the different applications of oil-cake, &c., probably it would have been more advantageous had the land been in a more saturated condition. Up to the 29th October none but very light showers fell, and during the total period of growth after the application of the manures 29·47 inches of rain were registered on 28 days. Shortly before harvest a few spots of rust appeared in the field, on the lighter soil generally first, and the grain was attacked by a fungoid disease; to this the deficiency of grain must be attributed.

The results were as follow :—

Manure per Acre.			Yield per Plot.				Yield per Acre.				Increase or Decrease per Acre.				Percentage of loss on drying Straw for 17 days.
			A.		B.		A.		B.		A.		B.		
Weight in Pounds.	Description.	Value.	Straw with Ears.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	
		RS.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	
...	Nothing	...	1,414	16¾	506	5¾	16,968	201	6,072	69	...	...	...	...	37
180	Saltpetre	12	1,918	23¼	784	9	23,016	279	9,408	108	+ 6,048	+ 78	+ 3,336	+ 39	28
90 372	Saltpetre ... ... White castor cake ...	12	1,524	23¾	980	8½	18,288	285	11,760	102	+ 1,320	+ 84	+ 5,688	+ 33	36
90 372	Saltpetre ... ... Bone charcoal ...	12	1,379	11¾	1,092	12	16,548	141	13,104	144	− 420	− 60	+ 7,032	+ 75	36
60 252 252	Saltpetre ... ... Bone charcoal ... White castor cake ..	12	1,792	8	1,148	9¼	21,504	96	13,736	111	+ 4,536	−105	+ 7,664	+ 42	37
90 189	Saltpetre ... ... Common salt	12	1,729	10	1,090	9¾	20,748	120	13,080	117	+ 3,780	− 81	+ 7,008	+ 48	21¼
378	Common salt	12	1,372	10¼	1,008	11¼	16,464	123	12,096	135	− 504	− 78	+ 6,024	+ 66	29¼
744	Bone charcoal ...	12	1,470	12¼	1,090	11	17,640	147	13,080	132	+ 672	− 54	+ 7,008	+ 63	30
372 426	Bone charcoal ... Old oil-cake, fresh ...	12	1,295	10¾	1,456	14½	15,540	129	17,472	174	+ 1,428	− 72	+11,400	+105	36¾
372 426	Bone charcoal ... Old oil-cake, decomposed.	12	1,480	12¾	1,568	10½	17,760	153	18,816	126	+ 792	− 48	+12,744	+ 57	37
744	White castor cake ...	12	1,624	10¾	1,176	17	19,488	129	14,112	204	+ 2,520	− 72	+ 8,040	+135	Not taken.
1,488	Castor seed husks ...	12	1,064	13¾	1,372	10¼	12,768	165	16,464	123	− 4,200	− 36	+10,392	+ 54	37

Looking at the A series alone, saltpetre gave by far the best results, the application being rather a heavy one; the lowest yield in the series was given where castor seed husks had been applied: this is not surprising considering the character of the manure, which, although it is probably very rich in ash constituents, from its nature will take a considerable time in decomposing; the white castor cake is composed of the kernel of the castor bean, and consists chiefly of carbonaceous with some nitrogenous matters, and although the former would improve the texture of the soil, the only active fertilizing substances are the latter. These experiments seem to show that, for this crop on our land, common salt is not of much, if of any, value; mixed with saltpetre in equal values it did not yield as much as half the increase a full dressing of the saltpetre did, whilst when applied alone there was no increase observable.

The figure in the last column of the table shows the percentage decrease on drying the straw, received from the several plots, in the open air for 17 days; they are the first of the sort recorded in India. It is well known that some manures induce plants to produce more succulent forage than others, and in estimating the value of fodder grown with different manures these characteristics must be taken into consideration.

CHAPTER IV.

CROPS.

The experiences gained regarding the habits and best methods of treating different crops will be given further on in detail, but among the many valuable results which have been obtained, the fact, that this country is preeminently favored with regard to forage crops, is conspicuous; and the more so because these crops can be grown with the greatest ease with ordinary care and skill, and their valuable attributes were formerly unknown and unsuspected. Of their value the following figures, giving the outturn of some field crops which have been grown on the farm are conclusive:—

Crops.	Duration of Growth.	Yield per Acre, of Green Fodder.	Remarks.
		Pounds.	
Yellow cholum ..	11 months.	51,870	Irrigated, 5 cuttings.
Do. do. ..	7 do.	48,168	Do. 4 do.
Do. do. ..	5 do.	17,024	Not irrigated.
Do. do. ..	119 days.	16,586	Irrigated, 1 cutting only.
Do. do. ..	63 do.	19,659	Do. do.
Do. do. ..	63 do.	42,850	A small portion of the latter.
Do. do. ..	88 do.	24,939	Irrigated, 1 cutting only.
Do. do. ..	88 do.	80,924	A small portion of the latter.
Maize	90 do.	12,226	Irrigated.
Sorghum saccharatum.	89 do.	16,444	Unirrigated.
Do. do.	107 do.	21,108	Do.
Planter's friend ..	106 do.	11,878	Do. (grown for grain).
Cumboo	75 do.	15,000	Do.
Do. and horse gram	78 do.	5,070	Do.
Do. do.	75 do.	8,346	Do.
Horse gram	71 do.	10,642	Do.
Do.	117 do.	7,318	Do.
Car paddy	133 do.	18,075	Irrigated.
Shamay	138 do.	47,151	Do. 2 cuttings.
Sugar-cane	9 months.	131,624	Do.
Hariali grass ..	1 year.	11,536	Do.
Guinea grass ..	141 days.	5,228	Not irrigated, 2 cuttings.

These results, obtained under such conditions as exist on the farm, show most conclusively that with good farming it is possible to raise abundance of fodder, and that too, it can be proved, of first-rate quality, without any difficulty. There is therefore no reason, from want of proper and adequate food, why the country should not produce good stock instead of the miserable degenerate animals on which it at present depends for the cultivation of the land and for transport on the roads.

A point, which is not understood by the cultivators of this country, is the imperative importance of harvesting crops before they are dead ripe. On this point the following experiment is instructive:—A small plot of car paddy, containing 388 square yards, was divided into two equal parts—one-half was harvested when the grain, on being pressed between the finger and thumb, ceased to exude any milky fluid, though the straw at the time was quite green; the other half was allowed to stand until dead ripe, as is the usual practice of the ryot. The first half was cut on the 13th June, and the remaining half on the 3rd of July. The following are the results:—

——	Square Yards.	Produce per Plot.		Produce per Acre.	
		Grain. LB.	Straw. LB.	Grain. LB.	Straw. LB.
Plot No. 1	194	56	245	1,397	6,112
Plot No. 2	194	42	170	1,047	4,241

Thus, the half of the plot early harvested produced per acre 350 lb. more grain and 1,871 lb. more straw than the half that was allowed to stand until it was dead ripe. Any one conversant with the appearance of paddy land a few weeks after harvest will readily account for this loss of 350 lb. of grain. It is chiefly shed on the ground, though a certain proportion is carried off by birds. The difference in the weight of the straw is due to the larger quantity of juice it contained when cut green, and, as at this stage in the growth of the plant its juice contains a large percentage of nutritive matters, this increased weight is so much gain; besides a ton of straw cut when dead ripe does not contain so much nutritive matter as an equal weight cut two or three weeks before it has reached this stage. The results of this experiment fully agree with the experience of European countries.

It has in fact been found that paddy may be safely harvested, as far as the yield and quality of grain produced is concerned, whilst the corn is still green; it must however be dry, not exuding any milk on pressure or rupture, and if so will gain its proper color after it is threshed or better still on the straw; whilst by cutting early little or no loss from shedding will ever be experienced. With most other crops the same experience holds good.

SUGAR-CANE (*Saccharum officinarum*)—(Tam.) Karoomboo; (Tel.) Cherukoo; (Hind.) Gunna.—A small plot, measuring about 2,000 square yards, was planted with sugar-cane in February 1872. The experiment was instituted merely to ascertain whether sugar-cane could be grown profitably on the ordinary soils of the Farm. The crop was manured with slaughter-house refuse only. The following are the results: the crop was planted during the first week in February, and was harvested at about the same period in the following year; it was planted in lines about 3½ feet apart; there were 35 lines; of these, 24 were sold to bazaarmen for Rupees 69-8-9, and the remaining 11 lines, which were the best, and were valued at Rupees 4 per line, were kept for farm use to provide cuttings for planting another crop. The total return was

thus, say, Rupees 113-8-9, or Rupees 274-12-6 per acre, against an expenditure amounting to Rupees 106-8-0, or Rupees 257-11-8 per acre, a large portion of which was taken up in raising water 20 feet high. However, in the case of a ryot who, instead of hiring all the necessary labor, works his land himself with the aid of an occasional laborer, the actual expenditure would have been very small, and the return obtained from the crop would have been ample to compensate him.

In order to test the capabilities of the crop as a fodder producer, an average row of canes was cut down in November; the canes weighed 1,162 lb. and the toppings 392 lb., or together 1,554 lb., equal to 131,624 lb. per acre, worth at least Rupees 290, so that it would have been far more profitable to have treated the crop as a fodder one, whilst, if the whole had been cut for fodder at the time the single row of canes was harvested, there would also have been a large saving in the cost of watering and weeding, and a large second crop would have been obtained. There can be no doubt but that sugar-cane as a fodder-producer is almost unequalled by any crop. Our Municipalities, with their abundant supplies of manure, might find it worthwhile to grow sugar-cane as a fodder crop; they might produce it in all favorable localities at Rupees 5 per ton, at which price it should meet with a large demand for feeding milch cows and draught cattle.

WHEAT.—(Tam.) Godumay; (Tel.) Godumalu; (Hind.) Gehun.—In 1875 several small plots were sown with wheat; some with seed obtained from the Nilgiris, and others with seed produced in the Coimbatore District; the sowings were made at different dates, between the 1st of January and the middle of March. The seed from both districts germinated well, and produced vigorous and healthy plants; however, only a very small proportion of them succeeded in maturing any grain, the result evidently of the high temperature that prevailed during the latter half of their growth. The experimental plots were all thoroughly cultivated and liberally manured, and irrigation water was applied when necessary. The species experimented with in this case was the *Triticum spelta*.

In 1876 two samples of wheat were obtained from Egypt, and sown but, though they germinated and grew fairly at first, no grain was produced; this may have been owing to a want of sufficient water, to a higher temperature than is usual in Egypt, and to the lightness of the soil on which the crop was sown.

In 1877 some further experiments were made, with seed obtained from Agra, but the results were very similar to those already given; the crop was however sown in October and harvested in January: the varieties sown in this case were both red and white native wheat.

MAIZE (*Zea mays*)—(Tam.) Mukka-cholum; (Tel.) Mokka-jonna; (Hind.) Mokka, Boota—has become a regular crop of the farm, occupying an important place as one of the best food crops we possess; it however requires better cultivation than that generally practised in Southern India, and so when good seed falls into the hands of the native cultivators its fate is inevitable and it rapidly deteriorates; it has been found that one average-sized Queensland maize cob grown under

good cultivation at Saidapet yields more grain than 12 of the cobs grown in the Vellore District. The value of the grain for human food is well known, excelling by far rice and the dry grains of this country, whilst at the same time it is more productive, and will thus support a larger population; on good soils 2,000 lb. of grain may be grown per acre without extraordinary management, and at the same time from 2½ to 3 tons of dry straw per acre may be expected; this straw is rich in saccharine matters, and is a valuable fodder for all kinds of farm-stock. The crop, however, should be well manured with organic manures, and will repay the applications of very heavy dressings; it is admirably adapted for growing in the intermediate spaces left in cotton cultivation, as it occupies the ground only about four months and when removed leaves the cotton plants as a crop on the land for the hot weather the usual objection of the unprofitableness of cotton culture being thus obviated; the maize crop paying at least all expenses and leaving the cotton, which is sold, for profit.

It is advisable to tar the seed before sowing to preserve it from the attacks of squirrels, &c. The seed should be sown, if the crop be taken alone, in rows about 3 feet apart, at the rate of about 30 lb. per acre; if grown with cotton, the rows of maize should be 4 feet apart, and those of cotton at the same distance, alternately. An experiment was made to find out the best depth at which to sow this crop, 50 grains were sown at each of the depths mentioned in the following table, with the results noted :—

When Counted.	Sown 1 Inch deep.	Sown 2 Inches deep.	Sown 3 Inches deep.	Sown 4 Inches deep.	Sown 5 Inches deep.
	Number of Plants that had appeared above ground.				
1st day ...	...	...	...	...	...
2nd „ ...	...	...	...	...	...
3rd „ ...	...	...	...	...	...
4th „ ...	...	...	...	...	...
5th „ ...	10	...	...	...	...
6th „ ...	27	4	...	...	...
7th „ ...	38	6	...	...	...
8th „ ...	39	13	4	...	...
9th „ ...	40	16	9	...	...

The 50 grains of maize sown at 1 inch produced 40 plants; the same quantity of seed sown at 2 inches produced only 16 plants; a similar quantity sown at 3 inches in depth yielded only 9 plants showing that when sown at a slight depth more seeds germinate and that they germinate more quickly; the results were, however, exceptional, and probably 1½ inches to 2 inches is the best depth at which to sow maize.

In harvesting, the cobs should be well matured before being gathered; if the weather during the time be favorable, the skins are best kept on the cobs until the seeds are perfectly hardened and glazed.

In the following table, the results of some experiments made in 1869 with this crop are given; the seed was sown on ridges 3 feet apart, and box manure had been applied to Plot 1 at the rate of 25 tons per acre;

to Plot 2 at the rate of 15 tons; and to Plot 3 at the rate of 20 tons. To Plot 1 in addition, 2 cwt. of bone-dust was applied. No manure was applied to Plot 4, the soil being in good condition, having carried no grain-crop since it had been reclaimed:—

Plot.	Area in Yards.	Date of Sowing.	Actual Amount of Seed sown.	Seed sown per Acre.	Date of Harvest.	Duration of Growth.	Rainfall.	Wet Days.	Yield of Fresh Cobs. Actual.	Yield of Fresh Cobs. Per Acre.	Yield of Grain (Dry). Actual.	Yield of Grain (Dry). Per Acre.	Yield of Straw (Dry). Actual.	Yield of Straw (Dry). Per Acre.
			LB.	LB.					LB.	LB.	LB.	LB.	LB.	LB.
1	5,774	Oct. 12th	36	30	17th Jan. 1870	97 days	20·89	40	7,080	5,837	1,851	1,551	7,456	4,944
2	10,647	,, 18th	54	25	17th ,, ,,	91 ,,	20·16	37	7,382	3,340	1,877	854	8,411	3,808
3	6,044	,, 31st	40	32	17th ,, ,,	78 ,,	18·17	32	1,932	1,449	1,063	851	7,271	5,722
4	4,918	,, 26th	27	26	17th ,, ,,	83 ,,	19·94	36	2,366	2,299	850	836	7,665	7,543

After allowing for all expenses the profit per acre was—

	RS.	A.	P.
Plot 1	28	12	3
Do. 2	15	1	0
Do. 3	20	11	0
Do. 4	38	6	2

A storm occurred when the plants were ninety-eight days old; the yield of grain from Plots 1 and 2 would have been much greater had not the effects of the storm necessitated the harvesting of the crop before it was matured. In forming any conclusion on the results of these experiments, the wretched nature of the soil must not be lost sight of. Not only is it very poor in the elements of plant-food, but it is physically a bad soil. It parts with its moisture too rapidly, and during hot weather becomes very hard and compact. However, if such soils—and there is a large area of similar soils in an uncultivated state in this district—will under maize give a profit of 25 Rupees per acre, the profit from maize cultivation on good soils must be large.

The following are the results obtained with a sowing made out of the usual season—September—, under occasional irrigation, and are worthy of notice, for maize being a tall growing plant is liable to injury by the high winds of the north-east monsoon. A plot of land measuring 1,950 square yards was, on the 15th of January 1875, sown with 14½ lb. of maize seed. The soil was a free sandy loam; it was twice ploughed, twice harrowed, manured with 1,500 lb. of oil cake and fourteen cart-loads of ashes, and ridged. During the growth of the crop the land was irrigated five times and once hand-hoed. The plants grew so luxuriantly, that it was found necessary to thin out a considerable number; the weight of fodder thus obtained was 1,134 lb. The remainder of the plants matured three months after sowing, and produced 1,738 cobs and 1,324 lb. of dry straw. The cobs were small from the plants having been too crowded on the ground: the total yield of cobs was 4,314 per acre.

Maize may be grown with success as a fodder crop. In the season 1876-77 a plot, measuring 2,418 square yards, was sown with this crop; and, under occasional irrigation, produced, between November 8th and February 6th, 6,108 lb. of fodder, which is at the rate of 12,226 lb. per acre. The rainfall during the period of the growth of this crop was 3·90 inches, and it received eight waterings; it was manured with about twelve loads of stable manure, and received a top-dressing of 50 lb. of saltpetre. It will be seen that it produces a fair crop of fodder; this fodder is highly prized in America as a food for milch cows.

GREAT MILLET (*Sorghum vulgare*)—(Tam.) Cholum; (Tel.) Jonna; (Hind.) Joar; the Durra of Africa—has been largely grown both for grain and for fodder; in the latter respect it has scarcely a rival. It can be grown on all classes of soil with success, but no doubt deep strong soils are best adapted for its perfection. For success, it must be sown on a well prepared deeply tilled and adequately manured soil. If to be grown under irrigation it is best to sow the seed on the ridge; the seed being thinly sown at the rate of 20 to 30 lb per acre only. If intended for fodder it should be cut when two-thirds grown, and will, under irrigation, yield as far as 50,000 to 70,000 lb. of fodder per acre in a year; whilst, if unirrigated, during the seven or eight months, it will produce four cuttings, yielding about one-third of that amount. If grown for grain it will produce from 500 to 1,000 lb. of seed, besides 4,000 to 6,000 lb. of good straw per acre. Under spade-culture in the Botanical Garden, on small areas of about 72 square yards, crops yielding at the rate of from 70,000 to 90,000 lb. per acre in one cutting have been grown; this shows that the crop amply repays high culture, and also what could be done by every ryot for the production of forage for his live-stock.

WHITE CHOLUM in a great measure possesses the qualities of the yellow variety, to which it is closely allied, and from which it differs chiefly in the color of the seed and the character of the panicle. It has not been experimented with so largely; however, as far as experiments have gone, the results have not been so satisfactory as those attending the cultivation of yellow cholum.

CHINESE SUGAR-CANE (*Sorghum saccharatum*).—This crop was first introduced on this farm from Sydney in the early part of 1870, and has now established itself here as one of our regular cold weather crops. It can be grown as readily and with as little skill as the ordinary cholums of the ryot, though, unlike our cholums, good results have not as yet been obtained from hot weather sowings. It has been tried over and over again in the hot season, but every time with the same want of success, even when the crop was occasionally irrigated; the seed always germinated well, and there were plenty of plants, but they were invariably sickly and stunted, and we never, even in the most favorable circumstances, obtained more than one-fourth of an average cold weather crop. This is very different from our cholums, which with water will grow well at any time of the year, and frequently better in the hot weather than in the cold season. Land intended for sorghum should be in good

condition physically and manurally; seed may be sown at the rate of from 10 to 20 lbs. per acre, either on the flat or on the ridge; the former method requiring more seed and giving lighter crops than the latter, but it is more expeditious and cheap. It has been suggested that transplanting might suit the habits of the sorghum plant, but it is seldom in this country that this can be done without great expense and seriously delaying farm-work. Transplanting may answer well enough for planting a few square yards with sorghum in a kitchen garden, but is altogether unsuited for operations in the field, excepting perhaps under irrigation.

The crop occupies the ground only about 100 days, even less if it be only grown for fodder. Sorghum is recommended as a fodder plant but not as a grain producer to the farmers of this country; it will yield two or three successive cuttings of fodder, under good cultivation when occasionally watered, but it does not throw out so many fresh stems as the cholums of this country do after each cutting.

IMPHEE and PLANTER'S FRIEND (*Sorghum Kaffrarium*) have been grown; they are supposed to have been originally obtained from the south-eastern coast of Africa. In America they are by many considered to be better sugar-producers than the Chinese sugar-cane, and all agree that their sugar is much more easy to crystallize. A few pounds of seed of the former were obtained from Sydney, and sown on the 30th of November 1870, but its growth was very unsatisfactory; it did not produce more than one-tenth of the crop Chinese sugar-cane yielded, whilst it required much longer time in coming to maturity. The canes were thick, but very short, and the presence of any more saccharine matter than is found in our common cholums could not be detected.

Planter's friend was first tried in 1875, and the results were satisfactory; it has been found to yield from 4,000 to 12,000 lbs. of straw, besides a crop of grain, per acre; it is, however, especially a fodder-producer and to obtain the best results should be cut when in flower. The straw of this variety is very rich in saccharine matter. The results which have been obtained show abundantly that both "Sorghum" and "Planter's Friend" are most valuable fodder-producers; the former gives a heavier yield of grain than the latter, but it may be remarked here that the grain of both varieties is at present unsaleable at Saidapet for use as food for man; that of the Sorghum because of the difficulty in removing the husk; that of the Planter's Friend because of a bitter taste which it possesses. For the production of sugar neither crop has been investigated on this farm, but there is every reason to believe that it would be a most valuable addition to the crops of the country in this respect; occupying the ground only about one hundred days, it will, without irrigation, produce in that time about 8 or 10 tons of green sorghum fit for crushing. From an experiment made, with very imperfect means of extraction, it was found that the crude juice showed specific gravity of 1·90 or 12° density on the Beaumé scale, which is higher than the average commonly obtained in America. A supply of the seed of some of the best sugar-yielding varieties has been indented for from the United States, but unless some adequate means of crushing the cane and purifying and evaporating the juice be also supplied, it will not be possible to do much in this direction.

SPIKED MILLET (*Penicillaria spicata*)—(Tam.) Cumboo; (Tel.) Sujjaloo; (Hind.) Bajree—is an indigenous plant, especially suited for cultivation, during a season of high temperature and light rainfall, on lands which it is not possible to irrigate. It is chiefly grown on the poorer classes of soils and does not produce very heavily. It grows well in some localities under irrigation, but does not come up to cholum either in productive powers or in the quality of the forage produced. Notwithstanding, it is a valuable crop for culture in the hot weather before the regular cold season crops are sown. The value of the fodder is referred to in another place; the grain meets with easy sale, but is of low value. It produces fodder at a time when there is generally great scarcity of cattle food in this neighborhood. It is possible always to have something green for the stock between the months of October and May; but the great difficulty is to find some crop that will yield green fodder during the months of June, July, and August. Of course under irrigation it is possible to grow yellow cholum, so as to afford a supply of green fodder throughout the hot season, but there are large tracts of country to which irrigation cannot be applied, in which cumboo will yield excellent green fodder during the season when the stock feeder finds it the most difficult to maintain the condition of his animals.

CROW-FOOT GRASS (*Eleusine corocana*)—(Tam.) Kelvaragoo; (Tel.) Taindulu; (Hind.) Ragi—is a fair fodder-producer, and yields a valuable food-grain under moderate irrigation. It is easily grown and is extensively raised under wells during the hot season, being planted out from seed beds. The best plan is to ridge up the land, as is done for maize and cotton, and to plant the seedlings on both sides of the ridges. The crop is a difficult and expensive one to harvest, owing to the ears never ripening at one time; and it is also costly to thresh, the grain adhering with great persistency to the panicle.

ITALIAN MILLET (*Panicum italicum*)—(Tam.) Tennai, (Tel.) Koraloo, Kora; (Hind.) Kora, Kala-kangni—has been grown on more than one occasion on the farm with tolerable success; it produces a fair crop of grain as well as straw. The grain is difficult to thresh, and does not command a ready sale.

LITTLE MILLET (*Panicum miliare*)—(Tam.) Samai, (Tel.) Shamaloo; (Hind.) Kungoo—is an inferior grain of no great value as a grain-producer; it grows readily on poor soils, and is a valuable fodder-producer under irrigation. The following experiment was made with it as a fodder crop:—A plot of land, measuring 744 square yards, was sown with 10 lbs. of Shamay seed on the 2nd of August. The crop grew rapidly and with great luxuriance; on the 25th of October, when most of the plants were coming into ear, the whole was cut down, and yielded 4,575 lbs. of excellent fodder. This was dried and made into hay which, when cured, weighed 1,411 lbs. After the removal of the first cutting the plants again started vigorously, and on the 18th of December another cutting, weighing 2,673 lbs. was obtained. This, when dried, yielded 925 lbs. of hay. The total return thus obtained from the plot during the four months that elapsed between the sowing of the

crop and the harvesting of the second cutting was 7,248 lbs. of fodder, which gave 2,336 lbs. of hay, equal to 47,151 lbs. of fodder, or 15,197 lbs. of hay per acre. The land had been manured with four loads of box manure, and the crop was watered seven times, but during the time it was on the ground the rainfall generally was copious, hence it was seldom necessary to irrigate; had it been necessary to water the crop regularly throughout the whole time it was growing, the cost of producing the fodder would have been largely increased: it was under Rupees 2 per ton.

COMMON MILLET (*Panicum miliaceum*)—(Tam.) Varagoo; (Tel.) Varagalu; (Hind.) Chenna—is a crop not worth much attention; the grain is very inferior, and commands a very small price in the bazaars, while it is a very slow grower, occupying the land a long time. In one case about 2 acres were put under this crop; the soil was prepared in the usual way and manured with 5 tons of fold-yard manure per acre; about 24 lbs. of seed was sown in drills 22 inches apart in the early part of October. The crop was harvested on the 1st of March, and yielded 456 lbs. of grain; the straw would not weigh more than half a ton per acre.

COUNTRY PADDY (*Oryza sativa*)—(Tam.) Nelloo; (Tel.) Urloo, Beeum; (Hind.) Dhan.—Both of the car and sumba varieties have been extensively grown from time to time. It has been found that the amount of water usually taken for irrigating the crop is far in excess of its actual requirements, which is the more to be deprecated for the crop is of a low type, and produces a poor food; it developes habits of idleness and unthrift in the people from the ease with which it may be grown, and consequently the adoption of perfunctory methods of cultivation; it is insanitary in its effects, causing under the system of the native cultivator, the presence of large bodies of generally stagnant water—a fertile source of malarious fever; and finally it monopolises water which might be far more usefully employed for irrigating maize or wheat, either of which crops might be grown with a tithe of the water now used for paddy, whilst the food they would produce would be equal or greater in quantity, and of far better quality. What the effects would be of an outbreak of a disease on this crop, which might, as the potato disease did in Ireland, destroy the greatest food resource of the people, it is difficult to contemplate; and yet the extension of irrigation works goes on, and consequently that of paddy culture. Paddy is at present the bane of South Indian farming.

As a fodder crop, paddy is a good producer. Numerous experiments with this object have been made on crops grown in the usual way; some from seed and others from transplanted seedlings; as a general rule, the best results were obtained from seed which had been sown broadcast.

The fodder was always harvested when the plants were in the shot blade, just before the ear appeared; the outturn was found to be about 18,000 to 20,000 lbs. per acre, which could be produced at the rate of 929 lbs. per 1 rupee, or at about Rupees 2-6-7 per ton. It is in the power of every ryot, who owns ordinary paddy soil with a moderate

supply of water, to produce similar results, while those who can apply the irrigation water by gravitation can produce the fodder at a much lower cost.

Of course, the distance from a market will limit the remunerative cultivation of paddy fodder to but a small area of the land now under paddy, still there is no doubt but that near our larger towns, within a distance of six or eight miles, a large proportion of the land might profitably be employed in growing fodder, not continuously, but in alternation with a crop of grain; and certainly during seasons of long drought, when cattle are starving and the ryot and his people idle, the water available, though it would not nearly suffice to bring a crop of grain to maturity, might be turned to account in growing a crop of paddy fodder. It is lamentable at such times, when large tracts of country are lying idle and cattle dying off, to see here and there a few feet of water in the tanks left unused, because there would not be enough to mature a crop, when it might suffice for raising a crop of paddy fodder. However, if a bad season comes, the ryot seems quite without resource; he folds his arms and blames his unfortunate fate.

Owners of horses could effect a very considerable saving in the cost of their stables by substituting paddy fodder for a portion of the grass now supplied by grass cutters. At the rate of wages usually paid to these people, this grass seldom costs less than 12 Rupees per ton. Paddy hay when chaffed is better, than when given uncut, as a horse fodder; the hay may be valued at Rupees 9 per ton, and the cost of chaffing it would be about one rupee per ton.

BURMESE PADDY.—A few pounds of each of the best kinds of Burmese paddy were obtained in 1873 from Rangoon. Each variety was sown on a separate plot of land, the cultivation adopted being precisely that under which indigenous paddy is raised. The general results were not good, a large number of the plants producing small inferior grain, but this may to some extent have been the result of the great change in climate, especially as the crops matured in the early part of the dry season, at which time the dryness of the air in Madras affords a very marked contrast to the state of the atmosphere most common in Burmah. These varieties of paddy are much more highly esteemed by natives than the ordinary paddy generally grown in Southern India.

CAROLINA PADDY.—Many experiments have been made with this variety, both with seed imported direct, and with seed raised in this country; the results have been highly satisfactory, and have proved that the native system can be adapted to its growth, if only less water be used, deeper cultivation be adopted, and more attention be paid to drainage: good results can be obtained either by sowing the seed at once in the paddy bed, or by sowing it in a seed bed and afterwards transplanting the plants into the paddy bed; either procedure may be justified by the peculiar circumstances of the ryot: it has been found that remunerative crops of country paddy can be produced on a soil that altogether fails in producing a fair crop of Carolina paddy, and also that a soil which one year produces a good crop of this grain may, in the next year, not be able

to produce even half a crop. Thus, soils which in 1870 produced as much as 2,000 lbs. per acre of Carolina paddy yielded in 1871 only half as much, though equally as well cultivated and manured: the explanation of this is simple; the soils which produced such good crops of Carolina paddy in 1870 were in a fresh state at the time the paddy was sown; they had not been under wet cultivation for several years, while those sown in the following year with this paddy had been under wet cultivation in the previous year, and had become more or less reduced, by the stagnation of the irrigating water in the sub-soil, to the condition of the more inferior descriptions of paddy land, or, in other words, to a sour, unhealthy, soapy condition, in which atmospheric agencies had been able to have no effect for good, in which plant food was either locked up and rendered inert, or formed into combinations more or less injurious to vegetable life, but whose surface to a depth of 2 or 3 inches was more or less healthy and capable of producing plants of a low type. It is easy to understand why, on a soil in this condition, Carolina paddy seldom does well, while country paddy may thrive. The former feeds deep down in the soil, it has long deep roots, varying in length, under average circumstances from 4 to 6 inches, while few of the rootlets are horizontal. It is very different with the roots of country paddy; nearly the whole of its rootlets radiate over the surface of the ground at right angles to the stem of the plant. They are seldom more than 2 or 3 inches in length, and are so interwoven as to form a sort of network well suited for supporting the plant on the semiliquid mud in which this variety delights to grow. Hence a soil in a bad physical state, if it only has a healthy surface 2 or 3 inches in depth, may produce fair crops of country paddy, though it will entirely fail in producing a crop of Carolina paddy. On such a soil the Carolina paddy would start as well as the country paddy, and would continue to grow as well, until its roots began to penetrate below the aërated soil, when its growth would be checked, and it would gradually turn yellow and sicken.

It was expected by many that the sample imported would deteriorate; this does not necessarily follow, for, although deterioration must take place if it be grown under very unfavorable circumstances, if properly cultivated it will not. In preparing rice from ordinary Carolina paddy, by means of the pestle and mortar, in the usual manner adopted by natives, the following results were obtained:—

	Per Cent.
Clean rice	67·24
Small rice	8·48
Tour	5·24
Husks, &c.	19·04
	100·00

Regarding the cultivation of the crop the following advice is given:—

"*Soil, &c.*—Carolina paddy has a very strong aversion to stagnant water; therefore avoid all land on which, from imperfect drainage, water is likely to collect and stagnate. Remember that water may stagnate in the soil as well as on its surface. Select good healthy paddy-land resting on a moderately porous sub-soil and with a surface sufficiently high that it will not become a swamp during the rains while it is yet sufficiently low to

admit of being watered at a moderate cost. In the endeavour to avoid a soil that is too retentive take care that you do not select one that parts too readily with its moisture, as a soil with this defect is as objectionable as one that is too retentive. Endeavour to select a soil that is neither too retentive nor too porous; in every taluq there are hundreds of acres of wet land that fulfil these conditions. These observations refer chiefly to the physical or mechanical condition of the soil. It is of much greater importance to secure a soil in a good physical condition than one in a high manural condition, as by the application of a suitable quality and quantity of manure the last-mentioned condition can so readily be secured. Land which is being put under irrigation for the first time will nearly always produce good crops of Carolina paddy.

"*Preparation of the Soil.*—The soil may be ploughed and worked in the dry state for sowing, or it may be ploughed under water and puddled. I much prefer the former arrangement; the latter is sometimes attended with advantages, but the evils which result from the wretched state in which the soil is left by the process are frequently of a very serious kind. But, whatever plan you adopt, take care to give the soil a liberal application of good manure during the time it is being prepared for the reception of seed.

"*Seed and Sowing.*—Choose a fresh sample of seed; it should be of a rich golden color; the sample should be uniform both as regards color and the size of the grain; if the seed is mixed with the seed of country paddy (which is the case almost invariably with all country-grown samples), and you cannot get a pure sample, you may, by using a fan and a bamboo sieve, remove the greater portion of the indigenous grain. Before you finally select the seed you should test its vitality. You may do so in the following way:—

"Take a shallow vessel—a soup-plate will answer admirably; place about 1 inch deep of good garden soil in the plate, and scatter over the soil 100 seeds; cover this with a piece of muslin, and over the muslin place about half an inch of soil. Keep the soil damp. After a few days the muslin with the upper soil may be lifted off and the condition of the seed ascertained. The number of seeds that have germinated will give the percentage of vital seeds. But you had better make duplicate experiments and take the average of the results obtained as the percentage of vital grain; ascertained in this way the results of the test are more trustworthy.

"Having selected suitable seed, and having prepared your land for its reception, you may proceed with the sowing. You may sow the seed at once on the land, or you may sow it in seed-beds and afterwards transplant the seedlings into the field. If you adopt the former of these arrangements, you may sow say, at the rate of fifteen measures per acre on either dry or puddled soil; if on dry soil, you may take the seed in its natural state and broadcast it or drill it in; but, if you prefer to sow on a puddled surface, you may sprout the seed before you sow it, but when this is done you can only sow broadcast. When transplanting is preferred, take care that the nursery-bed is *deeply* dug and thoroughly manured. When this is done the roots of the seedlings are small and compact, and the plants can be raised with ease and without suffering any injury in the operation. To produce seedlings for transplanting, sow eight measures, or about 18 lbs. of seed in the nursery-beds, for each acre of land to be planted; less will probably suffice, but this quantity will provide against any loss. The seedlings may be lifted for transplanting when three or four weeks old: they may be planted in the field in the puddled, or wet soil, at distances of from six to nine inches apart, a couple of seedlings being planted together. It may be good practice either to sow the seed at once

in the field, or to sow it first in the nursery, and afterwards to plant out the seedlings in the field. Thus, when the area to be sown is large, the season late, labor scarce, and seed plentiful and cheap, we would adopt the former plan, and the latter, when the seed is scarce and dear, the area to be cropped small, the weather favourable, and labor plentiful.

"*Irrigating** in whatever way the land is sown or planted, it should be moderately watered on the same day; this enables the seed to meet with a good bed and fixes the roots of the seedlings. It is seldom necessary to flood the land except to kill weeds or insects, especially after the plants begin to shade the soil. The endeavour should be to keep the land constantly damp, and not alternately in a state of puddle, and dry and filled with large cracks, as is too commonly the case with wet land under ordinary paddy culture."

"*After-cultivations*†.—These are of a very simple nature; it is only necessary to keep the crop free of weeds and to thin out a few of the plants if the crop grows too luxuriantly."

GRASSES.—Attempts have often been made to introduce the grasses cultivated in Europe and America into this country but with in general very partial success. On more than one occasion Prairie grass (*Bromus unioloides*), Italian rye grass (*Lolium italicum*), Perenial rye grass (*Lolium perenne*), have been tried, and the results have been that the seeds germinated well and produced healthy plants, which however died off on the approach of the hot season. Greater success has attended an attempt made in 1875 to introduce the Buffalo grass (*Stenotaphrum glabrum*) of Australia and America: a small box of roots was obtained from Sydney, and although six or seven weeks in transit most of them reached Madras alive. The plants have thriven since their introduction, and are spreading over the ground, but the area yet planted is too small to admit of any practical conclusions being arrived at regarding the suitability of the grass for general culture here. It is said to thrive in hardened alkaline soils on which other grasses will scarcely exist; in this country we have a large area of such soils.

GUINEA GRASS (*Panicum jumentorium*)—has, of all the grasses experimented with, been found to be the best; it is an exotic, but perfectly acclimatized grass, which is most easily propagated by root cuttings. Its culture is very simple, for if planted at the commencement of the rains, it soon strikes root and is then safe and out of danger for the future. If planted in rows it allows of interculture by cattle-power, by which means the land on which it grows may be easily cleaned; thus it affords an excellent crop for a rotation. It has been found capable of withstanding our longest and severest droughts without the aid of irrigation, and, although its energies remains dormant during such a time, the first rain makes it spring up again most rapidly. This power was never more clearly demonstrated than in a field planted in September 1875 measuring about 2 acres, which in May 1877, after

* The practice suggested here is based on experience obtained in the neighbourhood of Madras where the evaporation is great. In districts where the evaporation is less, and where the soil is moderately retentive, the American irrigation practice might be substituted.

† Hoeing is very beneficial and should be performed.

the great drought, was as brown and as dry as if it were totally devoid of life; the heavy rains which fell during that month however led to its immediate revival, and, before the third day of rain was over, green shoots had appeared all over the field which grew on and produced a good crop of fodder in two months, which weighed green 5,566 lbs.; this was followed by another cutting of 4,564 lbs. of dry fodder two months after, an amount equal to about 12,000 lbs. green. Not one per cent. of the tufts failed to throw out shoots after the rain referred to.

An idea still prevails that guinea grass must be irrigated, not only at the time it is planted, but regularly at stated intervals afterwards; that it must be taken up and be replanted on new ground at the end of every two years at the furthest, and that the fodder is not a suitable food for stock, and can only be used in small quantities for such a purpose. It is perfectly true that, if guinea grass is planted in the hot season, or during dry weather, when the soil contains scarcely a particle of moisture, and the sky is clear and bright, that the plants will fail completely if not watered a few times; but there can seldom be any necessity for planting under such circumstances. In the dryest parts of the country there is always a time when the sky is cloudy and the weather showery, and, if such opportunities are properly utilized for planting, the roots can be established sufficiently well without the aid of irrigation. Irrigation, of course, enables more cuttings to be obtained in a year, but it is never necessary for the maintenance of the crop. It is, however, most necessary to manure land for guinea grass well. It is general on the farm to plant this grass (the sets being obtained by dividing into several parts old tussacks from another field) on the ridge on a showery day, care being taken that they are planted uniformly at a distance of 2 feet apart in each direction, thus admitting the use of the plough between the lines of plants and across these lines at right angles; for it is advisable to pass a plough or cultivator occasionally through and across the crop, as the absorptive powers of the soil can in this way be kept up. This ploughing or cultivating should be repeated at any rate once after the removal of each cutting. Before the end of the second year the plants from frequent cutting will have formed large tussacks; these should be reduced by simple chopping with a spade, hoe, or man-vetti. It has been found best to make two cuts across the tussacks at right angles to each other, thus dividing it into four parts. Of these, three may be removed, and form excellent bedding for cattle stalls, the fourth remaining to perpetuate the crop. In this way there is no necessity to remove the plants to other ground, but care must be exercised to see that the soil is properly manured, as a crop which yields such large returns necessarily makes large demands on the soil. The fodder can be used for all kinds of stock; at first, it seems to disturb the digestive organs of some animals, but this is only temporary; cattle and sheep have been fed on it exclusively for months, not only without any ill-effects, but with the most satisfactory results. A guinea grass field is a capital place in which to graze working cattle during the hot season, while for ewes with young lambs better pasture could scarcely be discovered. It produces an abundant flow of milk in the ewes, without, what is common in such cases, disturbing the health of either mother or lamb. Care must, however, be always observed never to graze guinea grass too closely.

HARIALI GRASS (*Cynodon dactylon*)—the doob grass of Northern India, the couch grass of Australia and America—is a valuable, but overrated fodder plant, possessing great vitality and widespreading roots which are capable of propagating the grass from each section of them; it is suited to our long droughts and is also capable, under high cultivation and irrigation, of producing heavy cuttings of tough wiry fodder, which however must possess considerable nutritive qualities; on poor soils it is liable to be crushed out by inferior types of plants, but on those of fair quality it is very persistent and difficult to eradicate; the latter point is detrimental to its use as a crop to be taken in a rotation. When highly cultivated it yields heavily under irrigation and is grown for hay near some large stations. In 1868 there was a plot of this grass on the farm measuring 3 acres; it yielded fairly without irrigation, and during the year 1870-71 gave five cuttings yielding 8 tons, 13 cwt. of hay; this hay sold for Rupees 360-13-3, whilst the cost of curing it was Rupees 105. After this, the plot was kept for pasture, and in 1875 not half of the grass then growing was Hariali, the remainder being chiefly nutt-grass (*Cyperus bulbosus*) and finger-grass (*Panicum sanguinale*).

The following system is recommended for putting down this grass:—

"The land having been well cleaned should receive a dressing of fold-yard manure: when ploughing in the manure a woman should follow each plough and drop the roots in the open furrow, the succeeding plough covering them up, when its furrow is similarly planted, and the process repeated; a heavy harrowing and rolling complete the work."

Regarding the curing of hay the following remarks with reference to this grass are of value:—

"Hariali, like most other meadow grasses, should be cut immediately the flower begins to appear; in this state the juices of the grass are more nutritious, and the hay is far superior than when made from the fully matured plant. Besides, when cut before the seed appears, the plant is more vigorous and produces another crop much sooner. Hariali hay is generally spoiled in this country by being too much exposed to the sun's rays. It is quite unnecessary to bleach the grass, in order to make it into hay. The great object should be to retain the green color of the grass by drying it as quickly as possible. Under ordinary circumstances, two days, or at the most three days, should suffice for making the hay.

"Cutting should not commence until the dew is off the grass. The grass should remain on the ground for an hour or so after being cut. It should then be turned and tossed until sun-set. It cannot be tossed too much during a hot sun. To preserve the green color and aroma of the hay it is absolutely necessary to keep it moving. At night, if the dews are heavy, it should be put up in small cocks, each containing from two to three cwts. These cocks should not be tramped, though it is advisable to beat the outside smooth with the back of a rake, in order that, should a shower of rain fall, the water may run off without penetrating the mass. A single hay rope should be passed over the cock, to prevent it from being blown to pieces by a gust of wind. Next morning, after the dew is off the ground, the cocks may be opened again, and the hay spread out. It must be tossed and turned again, as on the previous day; care being taken that it is constantly kept moving. At the end of the second day, under ordinary circumstances, it will be fit to cart; though if the weather be at all damp or foggy it will be advisable to give it another day's sunning, of course putting it again into cock at night.

"Hay thus rapidly made is rich in saccharine matters, and is, therefore, very liable to heat and ferment; this, to a moderate extent, does no harm; in fact it gives the hay a good flavor; however care must be taken that it does not go too far and char the hay. If the hay is loose in a room, exposure for an hour or two in the hot sun, will put it all right, or a layer or two of dry paddy or cholum straw may be put through the mass. In the stack it is equally easy to prevent too great fermentation. I have found a single line of six-inch drain pipes placed at about the middle of the stack from the centre to the outside, a capital arrangement for keeping down the temperature. A thick bamboo, or a couple of hollow pieces of the stems of palmyrah or cocoanut trees, the one resting on the other so as to form a pipe, will equally effect the purpose, or, in building, two or three layers of dry paddy or cholum straw placed in a stack will prevent it heating to an injurious extent."

In 1874 some experiments with indigenous grasses were made, and it was found that the following grasses, on the soil and under the conditions met with at Saidapet gave the results mentioned :—

Name of Grass.	Botanical Name.	Remarks.
Melampary or Pishachi.	Panicum sanguinale ...	Average height 2 feet 9 inches. Upright growth without bottom grass. When green it yields a fair fodder, but unfit for making hay.
Shegapu Shamai ...	Dactyloclenium Ægyptiacum.	Average height 15 inches. Bottom grass abundant; a moderately good pasture grass; would afford a coarse hay.
Cinna Arricum ...	Panicum erucœforme ...	Average height 24 inches. A fair quality bottom grass. Stems and blades fine but rather wiry. A moderately good pasture grass. Makes coarse hay.
Koopary ...	Panicum distachyum ...	Average height 24 inches. A coarse grass; almost useless for pasture or for making hay.
Korani	Panicum Peeticœrii ...	Average height 24 inches. Destitute of bottom grass. Affords a moderately good fodder; but unsuited for making hay.
Varashamai ...	Setaria glauca	Do. do.
Ottarai	Lappago racemosa ...	Average height 12 inches. Has an abundance of bottom grass. Is a moderately good pasture grass. Affords hay of fair quality.
Vematheriti ...	Trachys mucronata ...	Average height 30 inches. A coarse inferior grass.
Poopillu	Poa fluvialis	Average height 9 inches. A fair amount of bottom grass. Blades and stem tough and wiry.
Punjapoo ...	Cyperus iria	A useless grass.

ELEPHANT GRASS.—About the year 1872 a tall, upright grass was noticed growing on the farm amongst some paddy that had been raised from purchased seed. The grass had evidently been introduced from some distant part of the Presidency, as it was unknown in the district around Saidapet. In habit of growth and in general appearance it resembles the small Millet (*Panicum Miliare*), but its seed is much smaller and more like that of the Spiked Millet. As the grass appeared to be a large producer, while the fodder seemed to possess some merits, some seed was collected and sown on a plot of land measuring 624 square yards, with the following results :—

Number of times ploughed	Ploughed in puddle three times.
Quantity of manure used	About 16 cart-loads of fold-yard manure.
Date of sowing	14th of March 1873.
Quantity of seed sown	9 lb. of seed ; broadcast.
Date when germinated	20th of March 1873.
Number of times weeded	Four times.
Do. of waterings	Twenty-five.
Date of 1st cutting	5th June 1873.
Weight of 1st cutting	1,576 lb.
Average height	3 feet.
Date of 2nd cutting	25th of September 1873.
Weight of 2nd cutting	1,132 lb.
Total yield	2,708 lb. = 21,004 lb. per acre.

HORSE GRAM (*Dolichos uniflorus*)—(Tam.) Kolloo; (Tel.) Woolawooloo; (Hind.) Kooltee—is a plant belonging to the natural order Leguminosæ. It is a hardy plant, thriving on the poorest soils. The soils of this district contain a very small proportion of lime; and this plant, like all leguminous plants, requires a good deal of lime before it can mature its seed. It has been ascertained from experiment, that, unless the manure applied contains a considerable percentage of lime, the tendency of the plant under better cultivation is to produce leaf rather than seed ; this tendency has been utilized, and by deeper cultivation and the application of a moderate dressing of manure we have succeeded in growing good fodder, at a very moderate cost.

Generally in preparing land for gram the following method is adopted :—After ploughing 4 to 6 inches deep, and harrowing, the seed is sown in lines, if the season is unfavorable and the soil poor, close together; if the reverse, far apart, at the rate of from 30 to 40 lb. per acre. During growth, the crop should be bullock-hoed once or twice, as circumstances demand, and hand-hoed at least once. The crop should be cut immediately the flower appears and removed the same day. The cost of growing a ton of fodder is about Rupees 3. The fodder makes good hay, which possesses a pleasant aromatic smell when well made; it however loses 75 per cent. of its weight in curing.

When cut before maturing its seed, the cultivation of gram improves rather than impoverishes the soil. There will always be a slight loss in the mineral constituents ; but still, as the plant appropriates such a large amount of atmospheric food, and stores it away in its roots, and as these roots, weighing from 800 to 1,000 lb. per acre, are left in the soil, its condition must be greatly improved.

The value of the crop for green manuring has been, and nutritive quality it possesses will be, referred to in another place. If grown solely for fodder four or five crops can be produced in a year, and thus the crop is admirably adapted for renovating worn out or improving poor lands.

BENGAL GRAM (*Cicer arietinum*)—(Tam.) Kadalay; (Tel.) Sanegaloo; (Hind.) Chenna.—has been tested on a small scale, but the results were not such as to induce the extension of its cultivation on the farm.

WILD INDIGO (*Indigofera paucifolia*) has been grown on a small scale for fodder with satisfactory results. Sheep are very fond of it, and it grows very freely on our poorest soils, keeping green during nearly the whole of the year, and may possibly become a valuable crop.

INDIGO (*Indigofera tinctoria.*)—(Tam.) Averie; (Tel.) Neelee (Hind.) Neel.—The growth of this valuable crop is attended with considerable difficulties. The seed time, adopted on this farm, is usually characterised by very uncertain weather, and the difficulty in obtaining as good a seed-bed for the seed as is requisite, is great, whilst the chance of a heavy fall of rain caking the surface of the ground, and thus preventing the young germs from coming through is considerable; but, when once a fair plant is obtained, we have scarcely any crop more hardy and less susceptible of drought. Land intended for indigo should be broken up well in September, or earlier if possible, and at some convenient time it should be ploughed and subsoiled as deeply as possible; every exertion must be made to remove weeds, especially those of a rapid habit of growth, for indigo, when it first appears above the ground, being a very small and tender seedling requires to have the fullest and freest liberty in order that it may get beyond that stage as rapidly as possible. Shortly before sowing, the surface soil must be brought into as fine a tilth as is possible, such as is desired for turnips in England; this can generally be attained without much difficulty unless very wet weather prevails, by the aid of those processes, which the agriculturist knows how and when to make use of, such as ploughings, rollings, and harrowings. When the requisite degree of fineness has been obtained, the surface should be rolled down in order to render it sufficiently compact and even to prevent the seed, which should always be sown in lines to admit of after cultivation, from being buried too deeply; in fact probably half an inch deep is amply sufficient for so small a seed, and, were it not that the sun is, whenever it appears, so powerful, scorching, and destructive to young plants, it might be sown with advantage on the surface and only covered, as clover is, with a brush harrow.

From 10 to 15 lb. of seed per acre should be sown, but even less will do if the seed is of first-rate quality, and than indigo, there is perhaps no crop the seed for which should be more carefully tested with regard to its vitality. Fresh seed carefully harvested from the first growth, not the last as is the common practice in this country, should always be used. In some cases it may be useful to steep the seed before sowing.

Having sown the seed with every precaution to ensure its early and regular germination, the appearance of the plant above ground must be awaited; this is perhaps the most anxious period of the crop's existence, for should heavy rain fall in all probability the sowing will be lost, even if the germs have just penetrated the surface. Should, however, success reward the endeavours of the cultivator, and the plant come up evenly over the whole field, nothing can be done until it has grown to such a size as will enable the lines to be discerned;

to expedite this, if there be any superabundance of grass in a field, it has been found useful to turn a flock of sheep in, which will graze down the grass leaving the young indigo intact, and thus allowing the bullock-hoes to be admitted some days earlier than otherwise. Following in the wake of the bullock-hoes, hand-hoes should be kept constantly at work, and, when their work is finished in all probability, unless the land be in a very foul state, the field can be left until the crop is ready to yield its first cutting.

If the sowing takes place at about the middle of November the crop will be ready for cutting by the beginning of March; after this cutting is removed, the crop should be bullock and hand-hoed, and in a good season a second cutting can be obtained in May, followed by a third in July; between the last two cuttings the same cultivation being performed as after the first. In a fair season on average soil, a yield of 200 bundles, measured with a seven foot chain, may be expected per acre; this would be worth at present rates nearly Rupees 30, whilst it would yield to the manufacturer 2 maunds of dye, if the indigo be good, worth about Rupees 90, at a very small charge for manufacture. It is well known that the ryot gets but a small share of the profits of the crop; probably he scarcely makes one-tenth of that which goes into the manufacturer's hands.

A crop of indigo, yielding 200 bundles per acre will weigh about 12,000 lb.; this amount of valuable organic substance can be recovered *in toto* for use as manure from the vat after the dye has been extracted; estimating this to be worth Rupees 3 per ton, we should get per acre manure in the shape of compost of a total value of Rupees 16, and thus indigo would become a restorative crop, and not, as it is now, where the plant is wasted, one of the most exhausting grown by the ryot. The valuable characteristics of the indigo crop do not however alone consist in the valuable compost it gives, for the roots, &c., left in the soil after the last cutting form a most useful preparation for a cereal crop, which should be taken next.

The value of the water, used in steeping the plant, for irrigation purposes is also great, containing as it does a considerable amount of the valuable ash constituents of the plant, and a considerable quantity of nitrogen. Indigo has been tried more often with failure than success, and the remuneration which it has been shown may be derived from its cultivation, may be pronounced exaggerated; such an idea however would be based on deductions derived from the wasteful, irrational, and suicidal practices usually pursued, and until they are corrected indigo will continue to retain the evil character it at present possesses. There are risks attending its culture, but large profits may be expected from it, and these far more than compensate for any danger which may be incurred.

LUCERNE (*Medicago sativa*).—Under irrigation this plant produces a large quantity of valuable fodder. A few pounds of English seed sown in September 1869 grew satisfactorily and yielded three cuttings of excellent fodder; it did not appear to be injured by the heat of the sun, though the thermometer exposed in the sun part of the time registered 135°, and the crop then looked vigorous and healthy. A similar result was obtained with some seed sown in 1876.

GROUND-NUTS (*Arachis hypogæa*)—(Tam.) Vayr or Nelay-cadalay; (Tel.) Veru or Nela Sanagalu; (Hind.) Moong-phullie.—On two or three occasions small plots have been planted with ground-nuts, but the results obtained have been unsatisfactory; there was always an abundance of leaf and stem, but the yield of nuts was exceedingly small. This is probably due to a deficiency of lime in the farm soil; for in an experiment made in 1876, it was found that a dressing of lime caused an increase in outturn of 83 per cent. of nuts and 10 per cent. of straw.

The crop requires a porous healthy soil, rich in potash, lime, &c., and as generally cultivated it is a very exhausting one, and, when frequently repeated, rapidly reduces the fertility of a soil; however, if the cake, made from the crushed nuts in extracting the oil, was given to the live stock on the farm on which the nuts were raised, there would be but a small loss of fertilizing matters. Usually, the ryot sells the whole of the nuts he produces, and never gets back the cake for feeding his stock; the result of this is that the soils, on which the ground-nut is cultivated, are becoming poorer and poorer every year, the fertilizing matters, which they lose, being turned to good account in the coffee estates of this country and Ceylon, and in England and France to which countries the ground-nut is now largely exported.

COTTON—(Tam.) Paratie; (Tel.) Puttie; (Hind.) Kapas.—When cotton culture was first attempted on the farm it was believed by most people that the experiment could yield no good results, as it was said it had been ascertained beyond all doubt that the climate of the district was altogether unsuited for the healthy growth of the plant, while general experience had proved in an equally conclusive way that cotton could not be raised on a poor sandy soil such as that which forms so considerable a proportion of the farm. The Collector of Chingleput in a report to the Board of Revenue, dated 7th June 1869, explaining why he had failed in getting any cultivator to take some cotton seed which had been sent to his office for distribution, remarked; "Due notice was given in the District Gazette, and the various farmers and proprietors were invited to apply for the seed, but no applications were received, the fact being that in this district little or no cotton is grown, the soil being quite unfitted for it." Again the Honorary Secretary to the late Farm Committee, in a report, dated 23rd June 1869, explaining to the Board of Revenue why certain cotton seed sent by the Board for experimental cultivation had not been sown, said: "The soil of the Government Experimental Farm at Saidapet is of a very sandy description, and the Committee considered it was useless to try the experiment of growing cotton." Evidently far too great trust was placed in the opinions expressed by the ryots of the neighborhood. On comparing the meteorological registrations of the district with those of the regular cotton-growing districts, it was found that there was nothing in the climate prejudicial to the growth of cotton, while the soil, though very much inferior to the so-called cotton soils, could, it was known, by the aid of manure be rendered sufficiently fertile.

It is true that on inferior soils such as those of the farm cotton cannot be raised without the aid of manure, whereas, on the more fertile

soils of the districts in which cotton is commonly grown, it can be; but the yield is always very small, seldom more than one-fourth the quantity that could be raised on the same soil if properly cultivated and manured. On the Experimental Farm, crops that have yielded 150 to 180 lb. of clean cotton per acre have repeatedly been produced, while the average produce in the cotton districts is only 75 lb. of clean cotton per acre. There are thousands of acres of land around Madras in no way inferior to the soils of the farm, now lying bare during two-thirds of the year, and during the remainder producing wretched crops of varagoo and horse gram, which might be made to yield remunerative returns under cotton; the extra expense on cultivation and manure would be more than counterbalanced by the smaller cost of conveying the cotton to the shipping port.

Experiments were made on a small scale at first, but with uniformly successful results, and now cotton has become a regular crop.

NEW ORLEANS COTTON (*Gossypium barbadense*).—This is the variety which is now preferred on the farm. It is especially suited for high cultivation; a dressing of manure that would be necessary to render our inferior soils fit for producing this cotton would cause plants of the indigenous variety to run to stem and leaf instead of increasing the yield; whereas the yield of the New Orleans plant under similar circumstances would be largely increased. Unless this variety is well cultivated it will not produce good results; this explains the numerous failures which have attended attempts at its general introduction. When the system of agriculture has been improved then improved types of plants may be safely introduced. In America, the New Orleans plant comes much quicker to maturity than it does in this country; to some extent this is due to the different climatic conditions it has to encounter in the two countries, the temperature of Madras being much higher than that of New Orleans, whilst in New Orleans the temperature in December sinks below the freezing point, which of course puts a stop to all vegetation. In New Orleans, the producing capabilities of the cotton plant are therefore more concentrated, from the shorter season in which the plant bears; in Madras, on the other hand, we have no such complete cessation of vegetable energy, excepting, during an unusually long drought and even then cotton does not perish; thus, we have no definite harvest time for our cotton, a gathering being afforded after every heavy fall of rain succeeded by bright hot weather.

The usual system has been to sow the crop in September on land prepared in our usual way for maize, viz. :—first, well ploughed; then harrowed, rolled, weeded, &c.; afterwards ridged at distances of two feet apart, in the furrow between these ridges farm-yard manure being applied at the rate of 20 loads, or about 8 tons per acre; the ridges split through the centre with a plough, one-half being cast over the manure on either side, thus raising new ridges; the ridges harrowed with the chain harrow to consolidate them, and maize and cotton sown along their tops in alternate rows; the chain harrow following and completing the work.

In 1876 an investigation was commenced with a view to discover the best linting season; the following figures were collected that year :—

—	Cotton in Seed received.		Cleaned Cotton received.		Percentage of Lint in Cotton in Seed.
	Total lbs.	Percentage	Total lbs.	Percentage	
January	102·5	4·18	34·65	4·71	33·80
February	168·0	6·85	59·00	8·02	35·12
March	251·0	10·23	91·74	12·47	36·55
April	330·0	13·45	119·25	16·21	36·14
May 1st to June 10th ...	315·0	12·84	102·00	13·87	32·38
June 10th to July 18th ...	372·0	15·17	98·00	13·32	26·34
July 18th to August 24th...	655·5	26·72	151·50	20·59	23·11
August 24th to Sept. 25th.	259·0	10·56	79·50	10·81	30·69
Total ...	2,453·0	100·00	735·64	100·00	29·99

It will be noticed that there is a great variation in the yield of lint at different times of the year, the cotton gathered during the earlier months yielding a much higher percentage than that picked later on. Thus the percentage of lint in the cotton gathered before June 10th was 34·92, and, in that which was gathered between June 10th and the end of August, it was only 24·28, or about 10½ per cent. less. The yield of cotton in seed, during the first of the above-named periods, was 74·75 per cent. of the total gathering. The gatherings in September show a high percentage yield of lint, but, as it was an unseasonably dry month, especially after the first week, the outturn in it must be taken as exceptional.

The rainfall of the four months—May, June, July, and August—was 1 inch less than the average of the previous sixty years, but more than 3 inches less than that of the previous ten years; the chief difference being in the fall during the month of May, so that the long dry season was rather more protracted than usual; no rain fell from December 17th, 1875, until April 30th, 1876, when, after a drought of about eighteen weeks, ·81 inch fell, followed by four slight falls before June 10th amounting in all to 1·30 inches, which falls, considering the temperature of the air, and the dryness of the soil at the time when they fell, could have but little permanent effect.

From these results it appears that after July it would generally be undesirable to keep cotton on the land; for, not only is the outturn shown to be chiefly given in the early months of the year, and that the percentage of lint produced after June is low, but also, during the showery weather of July and August, it is most difficult to keep down the weeds, and in all probability, if the crop is kept on the land for a longer period in the hope of obtaining rather more yield, the succeeding crop will be endangered, and great expense will be necessitated to clean the land again. It would also appear better to sow the cotton crop at an earlier date than has been customary; instead of September, August should be the month chosen; by this means, cotton-picking might begin at the end of December, instead of the end of January or the beginning of February which has been until lately the usual season. By this means a longer gathering season during the early months of the year, when the percentage of lint is greater, the staple longer, the sample usually

much cleaner and not stained with oil, would be obtained, and the temptation to keep the crop on the ground late, in hope of obtaining a further gathering, would be lessened.

During the year 1877, owing to the abnormal character of the season, it was impossible to collect any reliable figures; but during the season of 1878 those given below were obtained :—

Month during which received.	Amount of Seed Cotton received from the Field.				Amount of Clean Cotton received.				Percentage of Clean Cotton, Lint, obtained from Cotton in Seed.	
	No. 10 Field.		No. 33 Field.		No. 10 Field.		No. 33 Field.			
	Total in Month.	Percentage of Year's crop.	Total in Month.	Percentage of Year's crop.	Total in Month.	Percentage of Year's crop.	Total in Month.	Percentage of Year's crop.	No. 10	No. 33
1877	LB.		LB.		LB.		LB.			
December ...	1	·08	253·5	17·43	·25	·07	69	16·04	25	27·22
1878										
January ...	...	...	201·5	13·86	..	...	57	13·25	...	28·29
February ...	...	...	10	·69	...	...	3·25	·76	...	32·50
March ...	268	22·27	361	24·82	79	21·98	115	26·74	29·48	31·86
April ...	440	36·58	170·5	11·72	146	40·62	46	10·69	33·18	26·98
May ...	89	7·40	134	9·21	26	7·23	44	10·23	29·21	32·84
June ...	371	30·84	294	20·21	98	27·27	87	20·23	26·42	29·59
July ...	34	2·83	30	2·06	10·16	2·83	8·87	2·06	29·88	29·57
Total ...	1,203	100·00	1,454·5	100·00	359·41	100·00	430·12	100·00	29·88	29·68

With reference to these figures, it was observed :—

"I do not attribute the low percentage of lint shown in the early gatherings this year to the proportion of that substance being low, but rather to the fact that when gathered all the cotton in seed is slightly damp, and being brought to account in this state, an apparently low percentage of lint is shown. At ordinary times of the year our loss in ginning varies from 3 to 10 per cent.; the latter figure being reached in September when the cotton in seed is never dry when gathered, whilst early in the year, about April and May, the loss is at the former figure, the slight loss being due to dust and small portions of the cotton and to drying after receipt from the field. The loss in ginning in December and January this year, however, has exceeded the highest figure, and, if we attribute the excess loss above the average to the presence of larger quantities of moisture when received, nearly 10 per cent. should be deducted from the amount ginned, which would cause a proportionate increase to the percentage of lint yielded. For instance, two lots ginned on March 23rd were weighed off when dry, immediately before ginning and found to have lost, the first 14½ and the other 9 per cent. of their weight since gathering; during January when the dews are heavier

than in March, the loss in weight was probably considerably greater. When the deduction was made, it caused the wonderful figure of 39·7 per cent. of lint to be attained instead of 33·9."

It was found in 1877-78 that the first gathering took place between five and six weeks earlier than in 1875 or 1876, as the following statement shows :—

Date of Sowing.	Date of First Receipt.	Days to First Gathering.
5th September 1877 ...	18th December 1877 ...	104
18th November 1876 ...	31st March 1877 ...	133
23rd September 1875 ...	20th January 1876 ...	119
16th September 1874 ...	2nd February 1875 ...	139

These figures also show that the earlier linting season was not due solely to earlier sowing, although that operation took place about a fortnight before it did in 1875 and 1874, but to the unproductive period of growth having been reduced, temporarily or permanently—time alone can show—by twenty-five days or about 19 per cent. If this habit be confirmed, and by the use of the earliest gathered seed only in future it probably will be, a great step will be made; but not a greater one than the improvement which seems to have been effected in the style of the plant; formerly it was low, not above 2½ feet high, with a wide branching growth; in the season referred to many of the plants were four or five feet high with straight stems, and produced few side branches.

Referring to a shipment of three bales of some cotton of this variety made in 1873, a firm of professional brokers in London remarked :—

"We have carefully examined the sample of three bales cotton ex *Sultan* at Madras, and find it to be of an useful description of Salem character, ginned, fair color, silky, but rather weak staple, and worth about 6⅝*d.* per lb.

"This is the value which cotton of this quality would command to-day were it here in any quantity, say 50 or 100 bales. The color is good and the cotton is clean, but our brokers complain that the staple has been somewhat injured; they presume in the process of ginning."

Unfortunately, at the time when this sale was made, the cotton markets were unusually low, but still compared with the prevailing rates the valuation was satisfactory; at the same time Fair Westerns were selling at 6*d.* per lb.

EGYPTIAN COTTON.—In 1872 a plot was sown with this variety which grew admirably; it seems quite as well suited to our soils and climate as any variety that has been tried; it has, however, one serious defect—its spreading habit of growth—instead of growing upright like other varieties of cotton, it spreads over the ground; and, while a plant frequently covers with its branches a space measuring from 4 to 6 square yards, there are few plants 3 feet in height; the result is that it is exceedingly difficult to clean land that is under this crop—cattle, in working hoes and cultivators between the rows of plants, committing such havoc amongst the lateral branches; and we cannot afford the

amount of manual labor required to keep the land clean if bullock labor is not employed. The Egyptian cotton-plant produces large bolls, and its fibre is both longer and more soft and silky than that of the New Orleans variety; and in the ease with which the cotton can be separated from its seed, the variety possesses one advantage over all others that have yet been tried.

YCA VALLEY COTTON.—The seed of this variety was introduced by Mr. Clement Markham, when engaged in introducing the cinchona plant into India from Peru. It was obtained from the coast valley of Yca. During Mr. Markham's visit to this country in charge of the cinchona plants, it occurred to him that many districts in the eastern part of the Presidency possessed the same conditions of climate as the coast of Peru, and he, therefore, suggested that the plant might be introduced with great advantage into this district. The first supply of seed seems to have been received in this country during the latter part of 1864, and was distributed by the Board of Revenue to the Collectors in charge of the districts referred to by Mr. Markham: it is neither known what results marked the attempt to cultivate this species of cotton, nor what became of the seed produced, excepting a few ounces given to the farm by the Honorable J. D. Sim, C.S.I., in 1870.

From this small supply, sufficient seed to sow five acres was raised in two years. The plant is a perennial. If left unpruned it will grow to the height of 8 or 10 feet. It can be propagated by cuttings, but not with so good results as from seed. It bears transplanting well in the early stage of its growth, that is, before it is three months old, though it may be transplanted even when full grown, but it does not produce well when transplanted out so late as this. Unfortunately it has not been possible to maintain the crop; in 1873 it was remarked of it;—

"The small plantation of this variety of cotton has been unfortunate during the past year, having been two or three times attacked by a borer, which, beginning at the tips of the branches, works down the pith into the hard wood, destroying all as it proceeds. The only effective plan of checking the depredations of this insect, was to cut off the affected branches a few inches below the portion injured, and to collect and burn them; still the good result of this was only temporary, for, a month or two after each of these prunings, the plants were again in as bad a condition as before; but, by persisting in cutting away injured parts of the plant, I hope eventually to get rid of the pest, though many fine plants will, in the meantime, be sacrificed in spite of every care. The insect appeared in the Yca valley plants in all the plots, though these were at a considerable distance from each other: no other variety of cotton was attacked by it, though in one or two instance the plots of Yca valley plants were quite surrounded by cotton plants of other varieties."

A year later it was again reported:—

"The borer before noticed continues to commit great havoc amongst the plants, the shrubs have again and again been pruned of all their affected branches, which have been collected and burnt, but in spite of every effort the borer has continued its depredations, and many of the plants are now reduced to little more than bare stumps; the ground on which they are

growing has been thoroughly cultivated and various manural dressings have been applied, but the effect was only to stimulate the growth for a time the extra luxuriance produced, apparently only affording greater scope for the depredations of the borer and since then the few remaining plants have completely died out, this is to be deplored for the cotton was a most valuable variety ; for the quality of the cotton was certainly all that could be wished ; indeed, probably a better cotton was never produced in this country."

Samples of the produce were submitted to professional examination by His Grace the Secretary of State for India. The following was Dr. Forbes Watson's Report, through whom these valuations were obtained :—

"This cotton was submitted to, and valued at, from 10*d.* to 10½*d.* per lb. by the Cotton Broker's Association in Liverpool. It was likewise valued by a firm of brokers in the same place, and at the same time, at from 10*d.* to 11*d.* per. lb.

"It is considered to be similar to Peruvian cotton, and the prices named are nearly identical with those quoted for the best qualities ('good and fine') of Peruvian cotton at the same date, and it ranks higher than good 'Egyptian,' as will be seen from the subjoined table, which gives the means of comparing the value of the Yca valley sample from Madras, with that of similar samples in the Liverpool market during the week ending 28th September last :—

Classification and Value per Pound.

—	"Ordinary."	"Middling."	"Fair."	"Good, Fair."	"Good."	"Fine."
Cotton from Yca Valley seed grown in Madras in 1871, *value* 10*d.* *to* 11*d.* *per pound.*						
Peruvian	6¾	8	9½	9¾	10¼	10¾
Do.	..	8⅞	9⅜	9½	9¾	11½
Egyptian	7¼	8¼	9¼	9½	10¼	13

"It should be mentioned that, during the same period, American 'middling uplands' was selling at 9 $\frac{7}{16}$*d.*, and American 'middling fair uplands' at 10⅜*d.* per lb. while the price of the two best sorts ('good') of Indian cotton in the market at the time, namely, 'Hinginghaut' and 'middling ginned Broach' amounted to 8¾*d.* and 8⅝*d.* respectively."

Another independent report was as follows :—

"1*st.*—Rather mixed in color, part being very white, clean, and carefully ginned, the remainder dull, rather dead in color, and not so well ginned.

"2*nd.*—Partaking of the same character of the inferior portion of the first bale, but the whole of good staple, long and generally strong, but of woolly description and suitable for mixing with wool.

"This cotton resembles a quality received from the Figi Islands, raised there we understand from seed imported from the Brazil. There can be no doubt but this is most excellent cotton, by far the best we have seen from your Presidency. It is a good deal mixed both as regards cleanliness and staple, the latter being far from even throughout the sample."

In ginning, this variety yielded most favorably, the proportion being as follows, that of two well known Indian varieties is also given for the sake of comparison :—

—	Hinginghaut.	Bunnie.	Yea Valley.
Clean cotton	25·15	25·54	38·07
Seed, &c.	74·85	74·46	61·93
Total ...	100·00	100·00	100·00

In 1875 the Secretary of State resolved to obtain some fresh seed of the variety from Brazil, but nothing more has been heard of it.

BAHMIEH COTTON.—Some seed of this variety, which is supposed to be a hybrid between the ordinary cotton plant (*Gossypium vitifolium*) and the edible okro or ladies-fingers (*Hibiscus esculentus*) was obtained in 1877 from Egypt. The plant was recommended as being more prolific, and more upright in growth than the ordinary cotton plant; but in several experiments made on the farm the crop did not come up to the expectations formed of it from the descriptions given of it; for, from some reason, although the plants came up rather more uprightly than our ordinary cotton (New Orleans) after some time they began to throw out branches near the roots, and occupied fully as much space as the plants of other varieties do.

INDIGENOUS COTTON (*Gossypium herbaceum*).—A piece of land measuring about half an acre, was sown with Coimbatore cotton, and was manured and treated in the same way as an ordinary crop of New Orleans cotton. The result was very unsatisfactory; gigantic plants, heavily covered by leaves, were produced, but the yield of cotton was exceedingly small; the result is, however, quite in harmony with general experience, not only of native cotton, but all indigenous crops. With other indigenous varieties the following results may be noticed :—

"WESTERN.—A 5-acre field sown with this variety of cotton and maize in alternate lines yielded 1,766 lb. of seed cotton equal to 353 lb. per acre, and this was in addition to a fair crop of grain and straw from the maize plants that grew in alternate lines with the cotton plants."

"HINGINGHAUT AND BUNNIE.—These varieties are grown largely in Bombay, where they are said to be highly appreciated; the results obtained with them differed but little from those yielded by ordinary 'Western' seed."

Experiments have been made on more than one occasion in treating cotton as a biennial instead of an annual crop; but it has not generally been found to answer, for not only is the yield in the second year deficient, but the land also when kept under cotton for so long a period as two years unintermittedly becomes excessively foul, and this necessitates a heavy expenditure on cleaning it afterwards.

ROSELLE (*Hibiscus subdariffa*)—(Tam.) Pulichay kiray; (Tel.) Yerra gogu; (Hind.) Kaserica.—In 1875, a small plot of land was sown with this crop: the soil was a free sandy loam: after the land had been well manured, the seed was sown on February 1st at the rate of

24 lb. per acre, on the ridge. During the growth of the crop, the land was once hand-hoed, once bullock-hoed, and eighteen times irrigated. The seed germinated well, and the plants grew with great vigor; they were straight and almost without side branches, and averaged between 5 and 6 feet in height when ready for cutting, about three months after sowing. As the crop was grown chiefly in view to the production of seed, the fibre of the plants was not utilized; a few plants were, however, cut down when in flower, in order to ascertain the quality of their fibre, the result was very satisfactory, for the fibre proved to be long in staple, strong, and silky.

SUNN HEMP (*Crotalaria juncea*)—(Tam.) Janappa; (Hind.) Sunn—has been grown experimentally on two occasions; in 1875, a plot was sown on 2nd February, with seed at the rate of 50 lb. per acre on ridges two feet apart; during the growth of the crop it was watered eight times. The seed germinated well, and the plants grew with great luxuriance, but when they had reached the time for cutting, there was no fibre whatever in their stems. The soil of this plot was a sandy loam, and probably the high cultivation and watering were unfavorable to the production of fibre. In 1877 another experiment was made; for it a piece of land measuring 585 square yards was selected; it is a light and very sandy loam, recently levelled with a slope of about 9 inches in 300 feet. The land was prepared for an ordinary crop by ploughing and harrowing until it was reduced to a proper state, and the seed was then sown with the drill in rows 9 inches apart at the rate of 12 lb. per acre. The land had been manured with horse-manure at the rate of 12 loads, or about 4 tons per acre. The after cultivation consisted of two hand hoeings. The following table gives the outturns obtained; the plot was divided into three equal portions, and each of these again, excepting the last, was sub-divided into two; the whole of each main division was harvested on the same day, one-half being pulled and the other reaped close to the ground, the land however became so hard before the last plot was reaped that none of it could be pulled up with the roots. The results were as follow:—

Date of harvest ...	4th December.		15th December.		24th December.
Area of land ...	877·5 sqr. ft.	877·5 sqr. ft.	877·5 sqr. ft.	877·5 sqr. ft.	1755 sqr. ft.
Condition of plant when cut.	Flowering.		Seed pods formed and partly matured.		Seed ripened.
Method of harvest...	Cut level with ground.	Pulled up by the roots.	Cut level with ground.	Pulled up by the roots.	Cut level with ground.
Duration of steeping and temperature of water.	6 days; 78°		4 days; 82°		4 days; 82°
Yield of fibre ...	6 lb.	6·5 lb.	8·5 lb.	9·75 lb.	17·5 lb.
Yield of fibre per acre.	300 lb.	325 lb.	425 lb.	487·5 lb.	437·5 lb.

After being removed from the ground, the stems were tied in bundles of about 50—100 each and placed to steep in a tank, being weighted down to keep them under water; when considered fit the fibre was removed from the wood by splitting it off by the hand; it was then washed and dried; it came off in a very matted and tangled condition and there was not much difference in the quality or color of the different cuttings. All the samples being coarse, lightish yellow in color and of nearly similar strength; excepting that the last was rather stronger than any of the others.

JUTE.—(Tel.) Parinta; (Hind.) Singin janascha, Koshta. In 1874 a considerable area of land was cropped with jute (*Corchorus olitorius*). The experiments were made at different seasons from June up to the end of the year; in some the seed was first sown in seed beds, and the young seedlings afterwards transplanted into the field; in others it was sown directly in the field; in some experiments it was sown thinly on drills placed wide apart, in others on the flat in lines with but small spaces between. Some of the experimental plots were regularly watered during the growth of the crop, while others were nurtured by the rainfall only. The soil of nearly all the plots was a sandy loam. In all the experiments the seed germinated well, and the plants looked strong and healthy, but in nearly every instance they flowered when only about six inches in height, and threw out an immense number of lateral branches, these rendering the plant of but little value for fibre producing purposes.

In 1877 an experiment was made with the other variety of jute (*Corchorus capsularis*) on some light sandy soil which had been fairly manured; the crop was sown on September 5th, and when it appeared fit for harvest the following experiment was made—

Date of harvest	29th November 1877.	
Area of plot treated..	420 square feet.	
Condition of plant when cut	Seed partially matured.	
Method of harvest	Reaped close to the ground.	Pulled up by the roots.
Duration of steeping	11 days.	
Temperature of the water	82°.	
Yield per plot	5·75 lbs. fibre.	6·75 lbs. fibre.
Yield per acre	599 lbs. do.	703 lbs. do.

The fibre produced was very similar in both cases, but the increased yield of 100 lbs. per acre when pulled, shows that that method of harvesting seems to be the best; the weight alone however cannot be taken as a

conclusive proof, for the ends of the pulled-stem fibre were more woody than the other. The fibre was cleaned in the same way as the Sunn already referred to, and came out in a fine glossy silky state averaging from two to three feet in length, and being of great strength. In a better season and on a less sandy soil heavier returns and a better sample might have been obtained ; in this case, the crop suffered considerably from a drought in October and probably did not attain such a fine growth as it might have done.

RHEEA OR CHINA-GRASS (*Boehmeria nivea*).—In November 1875, 100 roots of this plant were received from the Superintendent of the Botanical Gardens, Saharanpore, North-West Provinces. The roots were much out of condition on reaching Saidapet, from the length of time (a week) occupied in transit. They were planted out at once, and a considerable number of them grew and produced healthy plants, but during the hot season the leaves of most of the plants became so bleached and discolored, apparently from the high temperature prevailing at the time, that it was deemed necessary to remove the plants to a plot of ground somewhat shaded from the sun. The change was beneficial, and the leaves assumed a healthy green color.

There is at present only a small plot of about 4 square yards growing on the farm, but from this in one cutting ¼ lb. of fibre was obtained. From the nature of the plant not less than four and perhaps more cuttings could be obtained per annum; but to do this abundant manure and some irrigation would be required. The cost of growing the stems need not be heavy, but until some machine capable of cleaning the fibre cheaply is produced, it is not of much use endeavoring to introduce the plant here where we have many other more easily manipulated, though perhaps not so valuable fibres.

MANILLA HEMP (*Musa textilis*).—An attempt was made in 1877 to introduce this plant, but although a few shoots obtained from the Botanical Gardens, Calcutta, were received in good condition, they were not apparently able to exist in the climate of Saidapet, and all died off within 12 months. In this Presidency it is, probably only in the country bordering on the western coast and on the slopes of some of the higher ranges of hills, that it will be possible to cultivate this plant without irrigation. Elsewhere the rainfall is too scanty, and the use of irrigation water would, in most instances, add considerably to the cost of raising the crop. Of course, there are tracts of land so situated that the irrigation water can be applied at a very little cost while good drainage can also be secured, but land so circumstanced is already under profitable culture.

TOBACCO (*Nicotiana tabacum*)—(Tam.) Pogheieley ; (Tel.) Poghaku; (Hind.) Tambaku—has been cultivated on two occasions on the farm, and the following advice to growers has been deduced from the results of these experiments. To raise plants for an acre of land, select as a seed bed a healthy piece of ground, measuring about 100 square feet, the soil of which should be friable (a sandy loam or loam), and well drained. Dig the ground over to a depth of 1½ feet some months, and a

second time about two weeks, before sowing the seed, and manure it heavily, if the soil is poor as much a country cart load of well rotted manure (about 600 lbs.) may be given ; and shortly before sowing the seed dig over the ground a third time. Divide the nursery into three beds ; each bed should not be more than 4 feet wide to facilitate watering, &c. Sow the three beds at intervals of four or five days ; by this arrangement ample time will be given to transplant the seedlings when ready. The best time for sowing is immediately after the monsoon rains are over, and about one ounce of good seed is sufficient to raise as many seedlings as are required to plant one acre ; therefore one third of that amount of seed will be required for each division. The soil having been reduced to a fine tilth, sow the seed broadcast on the surface and cover it by strewing some handfuls of mould or fine compost manure over it, taking care not to bury the seed but only to cover it ; if ants are troublesome strew some ashes over the surface to prevent their removing or injuring the seed. A temporary shed, or a roof of calico, should be erected over the nursery to protect it from sun and rain, and a deep drain dug around the beds to avoid excessive wetness of the soil. After the seed is sown keep the soil constantly moist, but not wet. During dry weather it will be necessary to water the beds daily two or three times for the first few weeks, this should be done with a watering pot with a rose, the pot being held low when watering, for otherwise the plants, which appear about eight days after sowing, and are very tender during the first stage of their growth, may be destroyed. Should the plants spring up very thickly they must be thinned out when about a week old ; and may be transplanted either into a separate bed or into another part of the same bed, when blanks exist ; each plant should be allowed not less than one square inch. The seedlings will be fit for transplanting about six or eight weeks after sowing.

The land intended to be planted with tobacco should be situated if possible near to the nursery bed ; the soil preferably should be of the same quality as the nursery bed, viz., a friable sandy loam or loam, with adequate drainage. Clay soils usually produce heavier crops, but the leaves are generally coarser and do not possess so much flavor after being cured. After being several times deeply ploughed, the land should be heavily manured and again ploughed and harrowed until the soil has been reduced to a fine tilth, and then it should be ridged. The distance apart at which to place the ridges depends on the nature of the soil and the species of the crop. With a good species, such as the Maryland, which grows to a considerable height and spreads its leaves very much, on a good soil the ridges should not be less than 3½ feet apart from centre to centre to allow weeding, hoeing, suckering, &c., without breaking the leaves. In the line the seedlings may be planted about 3 feet apart. Transplanting should be performed only in the evening, excepting on cloudy days when it may be done at any time. Before taking out the seedlings, the nursery bed should be properly watered in order that the plants can be easily removed without breaking their roots. The plants must be watered immediately after transplanting and the watering must be repeated every day for about a week unless any rain falls ; the plants should also be shaded during this time to protect them from the sun ; and blanks caused by the death of any plants must be filled up from the nursery.

After the plants have once taken root they grow rapidly and require comparatively little attention until they commence to flower. They will require a watering once in from four to eight days according to circumstances, and hoeing whenever the soil becomes too close and weeds make their appearance. Insects, which sometimes attack tobacco, must be searched for and killed. When the plants are about nine inches to a foot high, the soil should be heaped round the plants in cones and saltpetre should be applied unless the soil be very rich in potash; 200 lb. of saltpetre per acre produced a notable effect on the tobacco grown on this farm; the saltpetre was applied after being dissolved; some holes were made near the stem of the plant and a certain quantity of the solution poured into them.

The plants will commence to flower about two months after transplanting, when about 3 to 6 feet high. As soon as the flowers appear they must be broken off together with the top and bottom leaves. The suckers, which appear after the tops have been broken off, must be removed at least once every week, for if this is not done the quality of the tobacco and the size of the leaves will be seriously impaired.

The plants will be fit for cutting about three months after transplanting. Proper maturity is indicated by the appearance of yellow spots on the leaves; at which time they become very brittle.

When the plant is fit for harvest, the whole should be cut down at the bottom and removed at once. They must then be hung up, tying the butt-ends of the plants together over bamboos, &c., under some shade for wilting; any large tree standing near will answer the purpose, or, if none be available, a temporary shed should be erected near the ground: the plants should be handled as little as possible in order to avoid breaking their leaves. After being wilted they must be removed to the curing shed and hung close together until the leaves have commenced to turn yellow, when they must be hung wider apart to avoid injurious decomposition, and may remain thus until quite dry and fit for stripping. The time required before the leaf is fit for stripping varies from four to six weeks according to the weather; if the air be very dry, it may be necessary to pour some water on the floor of the shed to make the leaves more pliable; if the air be moist the leaves are apt to become mouldy, if this happens a fire must be made to promote the drying of the leaves.

Whilst stripping them, the leaves should be sorted according to quality; the best colored (golden) and large sized leaves give cigar wrappers and will fetch the highest price. After stripping they should be piled in heaps to undergo a further fermentation: when the heat rises too high, viz., to more than 110°, the tobacco must be repiled, but a well dried tobacco will seldom heat as much. Tobacco may be kept in bulk for some months, after which it may be made into cigars or disposed of otherwise.

PLANTAINS (*Musa paradisiaca*)—(Tam.) Vali; (Tel.) Ariti; (Hind.) Mauz.—Since 1872 there has always been a patch of greater or less extent under this crop near one of the wells; besides being a valuable and remunerative crop, it affords labor for the coolies during the dry weather: it requires careful tillage and heavy manuring to be brought to successful maturity, whilst it produces a large amount

of palatable food, as well as a fibre held in considerable esteem. The following account of a tope planted in September 1876 is interesting :—

"The plot measured 1·68 acres and was planted with sets placed in rows 6 feet a part either way. The cost of maintaining the plantation until the 1st of June 1878 was as follows :—

Year.	—	Total.			Per Acre.		
		RS.	A.	P.	RS.	A.	P.
1876	Planting	29	0	0	17	4	2
	Manure and Manuring	39	12	0	23	10	6
	Hoeing and Digging	17	6	0	10	4	3
	Watering	1	8	0	0	14	3
1877	Hoeing and Digging	34	14	0	20	12	2
	Watering	60	12	0	36	2	7
	Manure and Manuring	54	0	0	32	2	3
1878	Digging and Hoeing	7	8	8	4	7	10
	Watering	45	0	0	26	12	7
	Total ..	289	12	8	172	6	7

"This expenditure may be classified per acre as follows :—

	RS.	A.	P.	Per cent. of Total.
Planting	17	4	2	10·01
Manure and Manuring	55	12	9	32·36
Watering	63	13	5	37·03
Digging and Hoeing	35	8	3	20·60
Total Rs.	172	6	7	100·00

"The land on which the tope is situated is of very poor and varying quality, the greater portion being a coarse sand, and the remainder a sour stiffish loam, on which nothing has flourished, and on which the plantains even are comparatively stunted. The manure used was, for the first application in 1876, partly blood compost and partly poudrette, that for the dressing given in 1877—in September—chiefly blood compost, but box manure was also used for a few trees. Up to the end of 1877 the fruit yielded was of inferior quality, but since then, now that the last dressing of manure has acted, they have a flavor than which I have never noticed a better."

"Against the cost of production must be set the receipts up to the 1st of June for 332 bunches, which sold for Rupees 78-6-9, or Rupees 46-10-10 per acre; at the same date the trees standing on the ground were valued at Rupees 312-8-0, or Rupees 186-0-2 per acre, leaving a balance of Rupees 101-2-1, or Rupees 60-3-2 per acre in favor of the plantation after one year and nine months' existence. From February 1878 the weight of the bunches received was recorded, and although it was not large, 176 bunches weighing 2,289 lb., yet assuming the whole number received to have been about the same weight, the yield per acre in the months during which the plantation was bearing, amounted to between 2,500 and 2,600 lb. per acre. It was found by experiment that the yield of food (pulp) from the bunches was about 49 per cent. of their weight, so that the rate per acre was about 1,250 lb."

THE EGG-PLANT OR BRINGAL (*Solanum melongena*)—(Tam.) Kattrikai; (Tel.) Wankai; (Hind.) Baingan—is frequently grown on a small scale as a hot-weather crop under occasional irrigation; the crop is

a profitable one, especially for the small tenant who does not employ laborers. The plant yields its crop gradually through four or five months: total outturns of from 3,200 lb. to 4,200 lb. per acre have been obtained on the farm.

TAPIOCA (*Jatropha manihot*)—(Tam.) Maravullie—In 1871 a piece of land measuring 1,200 square yards was planted with cuttings of this plant obtained from Travancore. The land planted was a piece of poor sandy soil on the western side of the farm. A stiffer soil could have been provided, had this been thought necessary, but the small experiments made in previous years on moderately heavy soil seemed to indicate that a stiff soil was not the most suitable; while it is a well known fact that starch is developed more freely in tubers, and fleshy roots, when the soil in which they are growing is free and thoroughly aërated than when it is stiff and compact, and the commercial part of tapioca chiefly consists of starch. The soil was naturally a very poor one, and contained fully 90 per cent. of sand, but its poverty was to some extent, compensated by giving it a heavy dressing of foldyard manure. The land was first thoroughly ploughed, grubbed, and weeded. It was then ridged about 30 inches apart, and the manure spread in the open furrows between the ridges. The plough was then passed along through the centre of the ridges, throwing the soil over the manure on each side, thus raising a new ridge immediately over the manure. The cuttings were planted on the 17th of July on the ridges, in pairs crossing each other obliquely, each pair being planted about three feet apart; the ground being exceedingly dry at the time, the cuttings were twice watered (with chatties). They were afterwards left entirely to the weather, and received no other attention, except a slight weeding. The plants grew well and vigorously, but were too heavily covered with leaves for such a light soil as that in which they are growing, as, during the cyclone which broke over this district in the early part of May 1872, the whole crop was prostrated, and nearly the whole of the plants being permanently injured, no alternative remained but to gather the crop. The tubers weighed 656 pounds; but, as they were not matured, they possessed no commercial value.

The sandy soil seems suitable, but evidently too much foldyard manure was used (box manure is rich in nitrogenous, or leaf-producing matters); had less of it been used, and with it a small quantity of some phosphatic manure (bone dust, or animal charcoal) a good result would probably have been more certain.

ARTICHOKES (*Helianthus tuberosus*).—A plot of land, measuring about one-fifth of an acre, was ploughed and manured with four cart-loads of fold yard manure, and, on the 23rd of August 1870, planted with 35 pounds of Artichokes. The sets were planted about a foot apart in lines. The crop was harvested on the 8th of February following and yielded 331 pounds of tubers, or 1,655 per acre. The tubers were used as food for pigs.

In the earliest days of the farm both Beet-root and Mangel wurzel (*Beta valgaris*) were tried on a small scale, but it was soon seen that, although fair crops could be grown with care, the care required for these if given to indigenous crops would produce far better results.

BUCK-WHEAT (*Polygonum fagopyrum*)—has been tried on two occasions. In 1870 a bushel of seed was obtained from Sydney, and a portion of it was sown on the 8th of October on a piece of suitable soil in fair condition. The crop grew and flowered but did not succeed. In 1876 a plot of 1,300 square yards was sown with this crop, the seed having been obtained from Australia. It grew well and would in an ordinary season have doubtless attained maturity without being watered, but in the present case it was necessary to do so. The seed was sown on November 9th, and within ten weeks the crop was off the ground, leaving it ready for another. The yield was at the rate of, grain 167 lb., straw 1,136 lb.; per acre; but, under more favorable circumstances, it would, there is every reason to believe, yield better results. The crop is useful as a preparation for a cereal, or as a green manure. The fodder is good food for cows, and the grain yields, after the husk has been removed, a meal rich in nutritive matters. As an alternative crop with the cereals, as a catch crop after an early one grown for fodder, or grown as manure, buck-wheat can be recommended for some portions of the Presidency.

FLAX (*Linum usitatissimum*).—In 1870 a few pounds of Egyptian flax was sown on the 26th November. It grew very satisfactorily. It was cultivated as a dry crop, and matured its seed. The crop was not more than two-and-a-half feet in length; but the weather was unusually dry during its growth.

In 1876 a crop, giving similar results, was grown from Australian seed; it was sown in November and occasionally watered; it grew well, and was very healthy, but did not attain great length (only about 21 inches), as it was sown at wide intervals for the sake of seed.

PRICKLY CONFREY (*Symphytum asperimum*)—has been strongly recommended for culture as a fodder plant in India, but as far as the experiments made at Saidapet have gone, it has been found that it has little, if anything, to recommend it for cultivation for such purposes in the plains of Southern India. It requires a deep, rich, moist soil, under shade, and where these requisites can be secured may perhaps be grown with some success, whilst our ordinary forage crops will yield good returns under much more unfavorable conditions, as has been repeatedly shown in the many results obtained on the farm.

EGYPTIAN CLOVER AND BEANS, RAPE, VETCHES, LENTILS (*Ervum lens*), LUPINS (*Lupinus albus*)—and several other useful European crops have been experimented with and the results have generally been such as follows:—

"VETCHES (*Vicia sativa*) and RAPE (*Brassica napus*).—Australian seed—were sown, but, although the seed germintated well, neither crop succeeded. The vetches were apparently unable to withstand the heat, and the rape was attacked by caterpillars."

THE LOCUST OR CAROB BEAN (*Ceratonia siliqua*).—In 1866 some seedlings of this tree were obtained and planted on a piece of land in a good situation on the farm, but until 1877 they never

produced any fruit. There are now five trees, only one of which is a female; they are about 17 feet high, and the stems, at 1 foot above the ground, measure about 20 inches in circumference, but for the last few years they have made no apparent increase in size; this can scarcely be attributed to the climate, for the trees do not seem to suffer even in the hottest weather, but is probably due to the fact that the soil on which they are growing is deficient in lime. The trees were planted in a line, which arrangement, owing to the habit of the tree, is unadvisable, and might have explained the reason why no fruit had been produced before, were it not that the solitary female one has at last done so. The risk which must always attend planting the tree, owing to its being diœcious (the male and female flowers being borne on separate trees), and there being no method of ascertaining the sex of the plant until it flowers, is forcibly illustrated in this case, as of five trees planted only one of them has turned out to be a female one. To overcome this, grafting the seedlings should be adopted, as by grafting from known female and male trees, a certainty as regards the sex of the trees can be depended on; the grafts thus raised could afterwards be planted out at convenient distances, allowing a large number of female plants to each male one.

The value of the tree lies in the fleshy pulp which forms the covering of its seed; the seed also is capable of becoming a useful food when split and steamed.

ARECA-NUT PALMS (*Areca catechu*)—(Tam.) Camooghoo, Paakmaram; (Tel.) Poka-chettu; (Hind.) Sooparee.—In 1871 a quantity of areca-nuts were obtained from the Western Coast, a few were injured by heating on the way over, but most of them germinated. The seedlings were planted out on a piece of open ground, which had been well cultivated and manured, having good drainage, both surface and sub-soil; they were watered when necessary, and the soil about them was kept open and free from weeds. For the first few months they appeared promising; after this they gradually turned yellow and sickened, and one by one died off. Had they been planted under shade, more satisfactory results would probably have been obtained, as the plants exposed to the full glare of the sun suffered most; on the Western Coast, where the climate is moister, it is usual to plant areca-nuts under the shade of plantains, but whether or not the scorching weather experienced here for six months in the year is against their general cultivation in this district, they certainly need too much attention to make them a remunerative crop where the labor required must all be hired.

CHAPTER V.

LIVE STOCK.

CATTLE.—As milk in various forms is the chief, and most important animal food of the people of this country, and as the operations of tillage are performed with the aid of oxen only, the necessity for improving the milch and draught cattle of the country is undeniable. Native cultivators object to incur any expense when grass is scarce for providing special food for their milch cattle; they argue that bullocks pay for their food in the work they perform, but that the cow yields milk in such small quantities and for so short a period that she will not repay the cost of any special feeding.

WORKING CATTLE.—The ordinary cows of the ryot, when in full milk, seldom give more than one measure of milk per day, and seldom yield milk for a longer period than six or seven months; but there is no good reason why they in this country should not earn their food, by working at any rate, during the time they are not giving milk. In many parts of Europe, cows are very extensively employed as draught animals. During a month or two before calving, and, for three or four months afterwards, it might be inexpedient to work cows, but during six months in the year, they might, as draught animals, earn their food. There are in this Presidency, according to the latest statistics, about $8\frac{1}{4}$ million head of cattle; of these it may be fairly assumed that at least 2 millions are cows and heifers above 2 years of age. By working them lightly, 500,000 head of cattle, or from 10 to 15 per cent., might be added to the cultivating force of the country as it at present stands. There are no objections to be raised against such a practice in the interests of the cow; it would rather in fact be for her advantage, the moderate exercise entailed thereby and the extra food given her being likely to keep her in better bodily condition and in better health.

CATTLE IMPROVEMENT.—It will be best in endeavoring to improve the milch cattle that bulls of the best dairy breeds of Europe, should be imported by Government; those of Southern Europe direct, and those of Northern Europe from Australia. Experience has shown that the supposed weakness of constitution in cattle, the produce of a cross between an European bull and a country bred cow, is groundless, the offspring being perfectly capable of remaining out of doors all day; they, however, generally seek the shade of trees, such as usually exist in good pasture land, during the time when the sun is hottest.

In attempting to improve breeds of cattle, great care should be exercised in order that the increase in size bears a strict relation to the

supply of food available; in most parts of this Presidency during the dry months, even in a moderately good season, the food available is scarcely sufficient to preserve the lives of the undersized cattle kept by ryots, and would, therefore, be totally inadequate to do even this much for animals of a larger size. Before taking steps for improving the size of the cattle in the more backward parts of the Presidency, it is necessary that something should be done to induce ryots to grow fodder, &c., as food for their live stock; for as long as so many ryots consider that it is more economical to allow their cattle to starve or even to die in the dry season rather than to go to the trouble of growing fodder for their use, it will be exceedingly unwise to attempt to increase the size of the cattle they keep.

Native cattle like native laborers can adapt themselves readily to the bad conditions with which they have so frequently to contend; they can be starved down to, and be kept alive, for a time, on a daily allowance of food that would represent only a tithe of the quantity they could consume when in full health. This is the ordinary process to which they are subjected every hot season at the hand of their owners. But while it is possible to reduce gradually the daily food of a bullock until in amount it is not one-tenth of the allowance that should be given, it is not so easy again to increase without injury that allowance to the quantity necessary to support the animal in health; hence the enormous losses that are experienced in this country amongst live stock when, after a long drought, a sudden fall of rain produces a luxuriant and plentiful growth of grass. Few cattle die directly from starvation; the deaths in most cases are the result of the sudden supply of succulent food in abundance, greedily eaten by animals whose constitutions have been weakened by a long and gradual starving process.

Housing.—The general neglect of providing proper housing for cattle is another point which must be reformed before much progress can be made in improving them. For although it is only at exceptional times that the special value is particularly shown, the general usefulness of adequate housing is undoubtedly to be found in the general condition and health of all stock so treated; for instance, in Saidapet Taluk in May 1877 11,687 cattle and 7,218 sheep died from the effects of exposure in a cyclone; these may be taken to have been of an aggregate value of nearly 2 lakhs of Rupees, £20,000. In the Revenue Settlement Report of the taluk submitted by Mr. Banbury in April 1874, it is stated that the number of ploughing and milch cattle in it amounted to 28,316, and the number of sheep and goats to 16,929; the loss therefore amounted to 41 per cent. of the former and 43 per cent. of the latter; no doubt the terribly reduced condition of the stock caused them to succumb in such numbers, but had they been protected from the rain and chill consequent on their exposure, the loss would have been trifling: on the farm in a stock of 31 cattle not one was lost, whilst out of 300 sheep three or four died, possibly from the effects of the weather. Nor can much good be done until the practice of using any ill-formed brute as a sire is put a stop to; it would be well that all bulls, unless their owners can procure a license from an officer appointed for the

purpose, should be castrated, all licensed animals being branded, numbered and registered.

From some statistics collected in 1877, it was shown that average native cattle stand higher at the loins than behind the hump; this may be an advantage for draught purposes, by enabling them to throw more weight against the yoke. The length of leg in proportion to the depth of barrel is an excessive and general defect in the cattle of the country, forming as it does over 40 per cent. of the total height of the animals. Their girth is excessively low, not being more in full grown specimens than that attained by cattle of English breeds in less than twelve months.

The live weight of the cows, kept by ryots in the neighbourhood of the farm, varies from 200 to 400 lb., while the lightest of the bulls at the farm will weigh over 800 lb., it is consequently quite useless to put the bulls with at least 75 per cent. of the cows that are sent to them. It is a great mistake to expect to obtain a good cross between bulls of the large Nellore breed and the undersized, degenerate breeds of these districts. To improve the breeds of this district we must obtain a medium-sized bull of some breed known as suited for the dairy; with this view, in 1874, one bull, one cow and two bull calves of the Aden breed were imported. The Adens had a high reputation as dairy animals; the name Aden by which they are distinguished has probably originated from Aden being the port from which cattle of this breed are generally shipped, as they are not found in the neighbourhood of Aden, but are brought from districts situated at considerable distances from the coast. The animals imported were not nearly as good as it was expected they would be, although there is every reason to believe them to be average specimens; probably, with regard to their form and general quality, the breed has been much overpraised. As the cow has proved to be a good milker, her defects in shape may be overlooked, for it must be remembered that there are several highly-valued breeds of dairy stock in Europe, the cows of which are exceedingly irregular in form. If, by the use of bulls of the Aden breed amongst the dairy stock of the ryot, we can succeed in producing a cross the cows of which will possess larger milk-yielding capabilities, the experiment will have been fairly successful, and improvement in form may be attempted by the use of bulls of some other breed. It is however worth mentioning that, in the measurements already referred to, a bull of the Aden breed showed a better girth measurement than any native cattle.

Two buffalo bulls of the Guzerat breed have been constantly worked on the farm for the last eight years; they are most useful animals either for carting or ploughing, being admirably suited, on account of their enormous strength and steady action, for deep-ploughing. There is a very general impression that buffaloes will not work during the heat of the day, but we have never experienced any more trouble with them than with ordinary plough cattle, while their keep is decidedly much less costly than that of ordinary cattle, as they will eat any sort of coarse fodder, and are very hardy, being kept constantly in the open air tied under the shelter of a tree; their destructive propensities prevent, in their case, their being placed in a shed. Being far superior to the Madras breed of buffalo in form and strength, it was

hoped that they might do much good in improving it, but although they have served many cows in the neighbourhood the results are not easy to trace. Only long continued, well directed, and persevering efforts can ever produce any very clearly marked improvements in the cattle or agriculture of any country.

WORKING HOURS OF CATTLE.—Sundays excepted, the farm cattle work daily in the cold season 9 hours, and in the hot season 8½ hours. In the former they begin work at 6 A.M. and work until 10 A.M. when they are put into their stalls to feed and rest until 1 P.M., at which hour they are again yoked; they are employed until 6 P.M., when the labor of the day ceases; the animals are then placed in their stalls, where they remain until the following morning. In the hot season their working hours are different; instead of beginning work in the morning, at 6, they begin at 5-30, and in the afternoon instead of beginning at 1, they do not begin until 2 o'clock. These hours are shorter than is usual in this part of India, though for a hot climate they are sufficiently long for both the cattle and their drivers. Before these regulations were adopted the working day on the Experimental Farm for the draught cattle was about 10 hours in length throughout the whole year; however, it was seldom that the animals performed 10 hours' work; for, though they might be in the fields or on the roads for 10 hours, they were not actually employed during the whole time, and it is better in every way that they should be comfortably lying in their stalls during the extra hour or hour and-a-half of leisure, which the present regulations afford them, than be standing for a similar length of time on the roadside or on the head-lands. The cattle are now in their sheds during the hottest part of the day, and they now perform more work in a day than under the old system, being kept at work during the hours set apart for work. The amount of labor performed in a day by a pair of these cattle with European implements is—

	Acres.
In ploughing stubble land 4 to 6 inches deep	½
In ploughing fallow land 4 to 6 inches deep	¾
In harrowing, with a set of iron seed harrows, once over.	5
In harrowing, with an iron drag harrow, once over ..	3
In rolling, with a wooden roller, once over	5
In drilling, with 6 feet 6 inches drill	5—6
In scarifying, with 2 feet 6 inches grubber	2—2½

In all cases excepting the last only one pair of cattle is ever yoked to one implement. In England and on the continent, where draught cattle are employed, teams of two or even four pairs of oxen are often yoked to implements; we here think one pair sufficient; and in those countries, the "alternate" or "half-day system" of working oxen, is frequently adopted, while the animals, generally have a month or two at grass, during summer. The cattle are allowed 4 lb. of ground-nut oil cake and as much chaff, consisting of green fodder or straw or a mixture of both, as they like per diem, a little salt being mixed with their cake. The cost of maintaining a pair for a year on this system may be put down as follows :—

	RS.	A.	P.
Fodder throughout the year, at the rate of 100 lb. a pair daily, valued at 400 lb. per rupee	91	4	0
Cake throughout the year, at the rate of 8 lb. a pair daily, valued at Rs. 7 per 500 lb.	40	14	0
Interest on probable value of the pair of cattle, say, Rs. 100, at 5 per cent.	5	0	0
Deterioration, say, at 10 per cent. per annum, on Rs. 100, the value of the cattle ..	10	0	0
Shoeing throughout the year twelve times, at As. 12	9	0	0
Contingencies	3	14	0
Total Rs. ..	160	0	0

The total cost, Rupees 160, divided by 310, the number of working days in the year, gives a sum per diem amounting to Annas 8 Pies 3 as the actual daily cost of a pair of these draught cattle.

Dairy experiments.—The following is a record of the milk-producing qualities of a Nellore cow. The cow was an old one and was bought from a milkman, who was very unlikely to sell her for 60 rupees had she been more than a very ordinary cow; indeed, when offering her for sale, all he could say for her milk-producing abilities was that she would give daily about two measures, and she had been for some time in his possession. At the time of purchase she had a calf about one month old, and was much out of condition; her live weight, ten days after she was bought being only 536 lb. Her food was daily :—

- 4 lb. of ground-nut cake.
- 2 lb. of wheat bran.
- 20 lb. of green fodder (cholum, &c.)
- 15 lb. of grass.
- $\frac{3}{4}$ ounce of salt.

She was allowed to graze in a compound each morning, after being milked, for about a couple of hours; during the remainder of the day and during the night she was tied in a byre, and was always abundantly supplied with drinking water. She was milked at about seven in the morning, and at about five in the evening. She ate her cake (steeped) and bran while she was being milked, and her calf was allowed to be near her at the time, being permitted to strip any milk left; after this was done the calf was not allowed to go near its dam until the milking hour again came round. The following details show the quantity of milk obtained during the 12 weeks over which the experiment extended :—

—	Mornings.		Evenings.		Total.			—	Mornings.		Evenings.		Total.		
	Mrs.	Olks.	Mrs.	Olks.	Mrs.	Olks.	Pints.		Mrs.	Olks.	Mrs.	Olks.	Mrs.	Olks.	Pints.
1st Week ...	10	2	8	5	18	7	54	5th Week.	12	7½	10	5½	23	5	68
2nd do. ...	11	7½	10	4	22	3½	65	6th do....	14	7	11	7	26	6	77
3rd do. ...	12	2½	10	5	22	7½	66	7th do....	15	0	11	7½	26	7½	78
4th do. ...	11	6½	10	1½	22	0	63	8th do....	15	1½	11	2	26	3½	76
9th do. ...	14	6	10	5	25	3	73	11th do....	15	4	11	7	27	3	79
10th do. ...	15	3	11	4	26	7	78	12th do....	14	7	11	5	26	4	76

Referring to this cow it was observed:—

"While the yield of milk has increased, so also has the weight of the cow. In the space of four months 143 lb. have been added to her live weight, while the yield of milk has been doubled. 120 measures of most excellent milk is now obtained monthly, at a cost, for food and attendance, of Rupees 9-2-11, or at about 1¼ Annas per measure. Under the circumstances, I think, I am fully justified in concluding that *the increase of* 50 *per cent.* in the yield of milk is entirely due to the feeding. The milk is unusually rich; it yields regularly 12½ per cent. by volume of excellent cream, and the yield of butter confirms this, as from two measures (6·63 pints) of fresh milk, five ounces of butter is now regularly obtained. This is equal to a yield of one pound of butter for 21·2 pints of milk. In England the average quantity of milk required to yield one pound of butter is 22 pints. The milk of the Alderney, the Kerry, and of some of the other small breeds of dairy cattle is much richer than this, though of their milk seldom less than 17 pints are required to yield one pound of butter; indeed, I only know of one published instance in which a less quantity yielded one pound, and that was in a dairy of Kerrys grazed on the rich ever-green pastures of the south-west of Ireland; in that instance, 16 pints of milk regularly yielded one pound of butter."

In another case the produce of a cow, the result of a cross between a Devon bull and a Nellore cow, was recorded, commencing from the day the cow dropped her third calf, and extending over the whole period of milking. This cow calved again, about two months after she ceased to give milk; thus, in the period between her third and her fourth calf, she yielded milk during forty-four weeks, and was dry during eight weeks. During the whole of this time her daily food consisted of green fodder 40 lb., ground-nut cake 4 lb., wheat bran 2 lb., and about a dessert-spoonful of salt; the ground-nut cake was steeped and mixed with the bran, half being given in the morning and half in the evening; in other respects the treatment was the same as that in the case of the Nellore cow already referred to. The following are the registrations:—

—	Mornings.		Evenings.		Total.			—	Mornings.		Evenings.		Total.		
	Mrs.	Olks.	Mrs.	Olks.	Mrs.	Olks.	Pints.		Mrs.	Olks.	Mrs.	Olks.	Mrs.	Olks.	Pints.
1st Week..	25	5	20	3	46	0	133	23rd Week.	13	5	12	3	26	0	75
2nd do. ...	25	1½	19	3½	44	5	129	24th do.	14	3	11	4	25	7	75
3rd do. ...	24	6	17	1	41	7	121	25th do.	14	0	11	3	25	3	73
4th do. ...	23	6	18	5½	42	3½	122	26th do.	14	5½	11	2½	26	0	75
5th do. ...	25	1½	19	6½	45	0	130	27th do.	14	6½	11	2	26	½	75
6th do. ...	23	2	16	7	40	1	116	28th do.	15	2	11	¼	26	2¼	76
7th do. ...	15	7½	14	4	30	3½	88	29th do.	15	6¾	11	4½	27	3¼	79
8th do. ...	16	7½	14	3½	31	3	91	30th do.	14	2¼	12	1	26	3¼	76
9th do. ...	17	0	14	3½	31	3½	91	31st do.	13	7¼	10	7½	24	6¾	71
10th do. ...	15	6½	14	4½	30	3	88	32nd do.	13	1½	12	2¾	25	4¼	74
11th do. ...	15	6	14	2½	30	½	87	33rd do.	11	6¾	10	1¾	22	½	64
12th do. ...	15	4	12	7	28	3	82	34th do.	11	6	10	¼	21	6¼	63
13th do. ...	18	5½	14	4½	33	2	96	35th do.	11	1½	8	7	20	½	58
14th do. ...	17	4	14	5	32	1	93	36th do.	10	7	8	7	19	6	57
15th do. ...	16	½	14	5	30	5½	89	37th do.	10	1¼	8	2¼	18	3½	53
16th do. ...	16	1	14	3	30	4	88	38th do.	9	2	7	½	16	2½	47
17th do. ...	16	4	14	4½	31	½	90	39th do.	7	7½	6	2	14	1½	40
18th do. ...	16	2	14	5	30	7	89	40th do.	7	0	5	7	12	7	37
19th do. ...	16	6	14	6½	31	4½	91	41st do.	7	5	2	3¾	10	¾	29
20th do. ...	15	6	14	½	29	6½	86	42nd do.	3	7½	2	4¼	6	3¾	19
21st do. ...	14	4	14	0	28	4	82	43rd do.	3	3	1	2	4	5	13
22nd do. ...	14	4	12	7	27	3	79	44th do.	2	2¾	0	4¼	2	7	8

It will be observed that the return for the 7th week is 25 per cent. less than the yield of the previous week; this sudden diminution was due to the cow having been milked by a person to whom she was not accustomed, the man who always milked her being absent owing to sickness; this change proved very unfortunate, for though, when the regular milker returned to his duties in the 13th week, the yield somewhat improved, it was still very much below what it would have been had not the change referred to occurred. It is necessary to call particular attention to the facts just stated, for, though some cows will give the same quantity of milk to any milker, it is well that it should be known that with some cows a change in their attendant may lead to a very large reduction in the quantity of milk obtained.

During the first four months of this experiment the calf was allowed to take about one measure of milk daily and about half a measure during the next two months; this milk was of course not brought to account in the foregoing registrations; it is an advantage in this country to allow the calf access to its mother before and after milking as is customary, for not only does the cow yield her milk more freely, but, what is of more importance, her udder is thoroughly stripped after each milking; and, with the help of other food, the calf can be reared at a very moderate cost.

The total quantity of milk yielded was 1,177 measures and 1½ ollocks, or 3,397 imperial pints. The expenditure was as below:—

	RS.	A.	P.
365 days green fodder, 40 lb. daily, at 300 lb. per rupee	48	10	8
365 days ground-nut cake, 4 lb. daily, at 65 lb. per rupee	22	7	4
365 days bran, 2 lb. daily, at 32 lb. per rupee	22	13	0
Salt, and bedding straw	12	0	0
Attendance	36	0	0
Total Rs. ..	141	15	0

The total expense thus amounted to Rupees 141-15-0; but from this must be deducted the sum, Rupees 25, realized by the sale of the calf, leaving Rupees 116-15-0 as the cost of 1,177 measures of milk, which is equal to one Anna and seven Pies per measure. A yield of 424⅓ gallons of milk, in the year, is very satisfactory, considering the conditions met with in this country. In Ireland, a cow of the Kerry breed, which is the favorite dairy breed in that country, will yield during the year from 450 to 500 gallons of milk; Mr. John Haxton in his book "How to Choose a good Milch Cow" says:—"Mr. Crosby's dairy of Kerry cows at Ardfort Abbey, near Trallee, averaged 42 in number during the seven years ending with 1861, and averaged 488 gallons of milk a-piece, per annum during that time, varying from 411 gallons in 1851 to as much as 542 gallons in 1856," and Mr. Morton in his "Hand-book of Dairy Husbandry" says:—"from these instances, it may be safely gathered that the average yield of well-managed cows varies from 480 to 600 gallons of milk a year, according to breed and size, the Kerry under good management yielding the former quantity, and the Yorkshire, short-horned, and cross breeds the latter."

The quality of the milk was, throughout the whole period, exceedingly good, yielding by volume on the average from 11 to 15 per cent. of cream.

A daughter of the cow, last referred to, by a Nellore bull, calved when about three years old. The following registrations show her yield of milk, per mensem, during her milking period :—

—	Mrs.	Olks.	—	Mrs.	Olks.
1st Month	110	$7\frac{3}{4}$	7th Month	116	...
2nd do.	114	$6\frac{1}{2}$	8th do.	102	$6\frac{1}{4}$
3rd do.	106	3	9th do.	70	$6\frac{1}{2}$
4th do.	111	$3\frac{3}{4}$	10th do.	56	$4\frac{1}{2}$
5th do.	112	$5\frac{1}{4}$	11th do.	40	$3\frac{1}{2}$
6th do.	115	$4\frac{1}{4}$	12th do.	27	$5\frac{3}{4}$
			Total 3,134 pints or ..	1,086	1

Considering the age of the cow, the yield of milk was very satisfactory. This cow dropped her first calf on the 13th of August, when, as before noticed, she was only three years old. She was milked during nearly 48 weeks, and had her second calf, scarcely twelve months after the birth of her first; thus, she had had two calves when just four years old. The foregoing facts show how much good can be effected by using bulls of a superior breed and by providing suitable fodder and other food in sufficient quantity for the cows throughout the year. As a general rule, the cows of this country seldom drop their first calf until they are five or six years old.

The following statistics, referring to the Aden cow, already alluded to as having been imported in 1874, show conclusively that she is a good milker, for besides yielding the quantity of milk recorded, she reared her calf; her milk also is excessively rich, yielding butter at the rate of 1 lb. to every 16·3 pints of milk, and although this butter is probably not so free from water, &c., as English, the produce compares most favorably with the best English breeds, being better in this respect than that of either of the cows already mentioned. The management of the cow was in this case similar to that followed with the cross-bred cow referred to above. In the month of October 1877 being in season she took the bull and was thus due to calve again in July; to her being in calf the rapid diminution of the milk after the eighth month may be attributed. The cost of keeping the cow for twelve months may be put down as follows :—

	RS	A.	P.
10,800 lb. of fodder	36	0	0
1,440 lb. of oil-cake	28	12	10
720 lb. of bran	14	6	5
Attendance and sundries	12	4	9
Rupees 7-10-0 per mensem or per annum Rupees.	91	8	0

The following table gives the monthly registrations, commencing from May 4th, 1877 :—

—	Mornings.		Evenings.		Total.			—	Mornings.		Evenings.		Total.		
	Mrs.	Olks.	Mrs.	Olks.	Mrs.	Olks.	Pints.		Mrs.	Olks.	Mrs.	Olks.	Mrs.	Olks.	Pints.
1st Month.	30	1½	26	0	56	1½	171·6	7th Month.	43	4½	39	3	82	7	253·2
2nd do.	34	5	34	2	68	7	210·2	8th do.	53	7	30	1	84	½	256·9
3rd do.	36	0	36	0	72	0	219·8	9th do.	42	6	35	½	77	6½	237·7
4th do.	42	3	31	2	73	5	225·0	10th do.	38	0	26	1½	64	1½	195·9
5th do.	43	7	41	7	85	6	261·9	11th do.	32	2	26	5	58	7	179·8
6th do.	47	7	44	7	92	6	283·5	12th do.	7	1½	8	1½	15	3	46·7
								Total ...	452	4½	379	6½	832	3	2542·2

This cow only weighed about five hundred pounds; so that the total yield, 318 gallons, is very good. In this case the cost of the milk was one Anna and eight Pies per measure, not deducting the value of the calf; taking this result in conjunction with the data already given, it may fairly be assumed that with care and good feeding any quantity of milk of first-class quality may be produced in Madras at a price below that mentioned.

It may not be out of place to remark here that the adulteration of milk with water (if the water be good) is, after all, only a minor evil, the loss being only in the pocket. It is a far more serious matter if the milk has been obtained from a cow suffering from disease, or if the water the cow drinks, or that added to the milk, contain minute forms of organized life. Though the ill-effects of drinking the milk of a cow suffering from disease are not always apparent, especially in the case of adults, there are many well authenticated cases in which disease and death have been traced directly to the ill-effects of drinking diseased milk; chiefly amongst children, who are the largest consumers of milk in its unprepared state. Recent microscopic investigations have revealed the fact that, if a cow is allowed to drink impure water (and few dairy cows drink anything else in this part of India) containing animalculæ, the same animalculæ may be found in its milk. It has been suggested that officers should be appointed to inspect the milk supplied to consumers in Madras, but mere inspection of the milk would be useless. The only effective way would be to inspect the dairy cattle and dairies, and to allow no milk to be sold for consumption except by licensed dairymen.

Useful though the Lactometre is in ascertaining whether the quality of milk reaches a certain standard, it is not a trustworthy guide as a means of ascertaining the quantity of water fraudulently added to a sample, if the quantity added is less than 20 per cent. of its volume. Samples of pure milk contain water in various proportions from 80 to 90 per cent. and it is almost as easy for the dairyman to water the milk before it leaves the cow, as afterwards by giving the animal succulent watery food, and, in this case, the milk would be none the less pure.

Butter-making.—In endeavoring to discover the best manner of making butter, the following are a few of many experiments made:—

1. (*a*) A measure of milk, which had been set aside from the previous night's meal, was when churning commenced at a temperature of 81°. The butter was a long time in appearing, and was collected with great difficulty; the total yield being only three-

quarters of an ounce. The milk in this instance underwent no preparation before being churned; it was slightly soured; but this was caused by natural agencies.

(*b*) Another experiment of the same kind (excepting that, in this instance, the milk was artificially heated to 110° just after being taken from the cow) was made with two measures of milk, and the total yield of butter was only one and a quarter ounces.

2. A measure of milk, fresh from the cow, was placed in the churn, its natural temperature at the time being nearly 100°; cold water was added, reducing the temperature to 85°. After churning for upwards of half an hour, the butter at length appeared, but the total yield was only half an ounce.

3. (*a*) A measure of milk, immediately after it left the cow, was artificially heated to 110°; about one fluid ounce of churn milk from the previous churning was then added, and the whole placed aside in an ordinary milk bowl. Next morning when churning commenced the temperature was 84°. The butter was a very long time in appearing, nearly a full hour, and the total yield was only one and a quarter ounces. The quantity of churn milk used was evidently far in excess of the requirement; the milk had assumed such a coagulated condition, that it was exceedingly difficult to separate the butter from the curd.

(*b*) The experiment was again made with two measures of milk, less of the churn milk being used. The butter appeared in much less time, and the total weight obtained was four ounces.

(*c*) The experiment was again performed with the same quantity of milk, still less of the churn milk being used. The butter came within 20 minutes, and the yield was four and a half ounces.

(*d*) The experiment was repeated with the same quantity of fresh milk several times, with varying quantities of churn milk, until, with from six to ten drops per measure, five ounces of butter were regularly obtained, generally within 15 minutes from the time of commencing to churn. In very hot weather a smaller quantity of churn milk was found to be enough, but in cold weather (when the temperature of the milk was less than 70°) one fluid ounce per measure was not too much.

Based on these experiments, the following advice is given on the subject. Immediately on receipt from the cow of the morning's milk strain and measure it, putting the quantity needed for butter in a tin can, which should then be placed over boiling water in an open chatty, on a charcoal fire, the milk heated to 120° and then emptied into a bowl; before cooling add from six drops to one fluid ounce of churn milk per measure, as the weather is hot or cold; then place the milk aside in as cool a place as can be provided (though a hot dry place is greatly preferable to a cool damp place). The milk obtained at the evening milking should be treated in a similar manner, excepting that a few additional drops of churn milk must be added. Next morning both lots of milk should be put together into the churn. If the temperature of the milk is over 80° cold water should be added to it; but care must be exercised not to fill the churn more than two-thirds full. To keep down the temperature of the milk (which will rise during churning) the

churn* should be placed in a chatty of cold water, and churning commenced by raising and depressing the plunger—for the first five minutes, at about 50 strokes per minute; for the second five minutes, at about 80 per minute; and, when the butter begins to come, at about 120 per minute. Butter generally begins to appear in 12 or 15 minutes after commencing to churn. Do not remove any until a moderate quantity has accumulated; and then continue churning for about five minutes after the first butter is removed, when a second supply may be taken out, and the churning again resumed for about five minutes longer, or until all the butter is finally obtained, the whole operation generally lasting from 20 to 30 minutes. Great nicety is required in removing the butter, and, in manipulating it afterwards, and such a degree of cleanliness is demanded that one shudders to think of the preparation butter must undergo at the hands of the ordinary dairyman. After removal from the churn, the butter should be thoroughly washed with cool filtered water, and, during the operation, worked with a bamboo paddle. To facilitate the washing operation, cold water may be placed in a goglet fixed over the vessel containing the butter, the bottom of the goglet being perforated with holes of sufficient size to allow a gentle flow of water over the butter; the washings pass over the sides of the bowl, and can be collected in a vessel beneath. This operation, when carefully performed, need not occupy more than 10 minutes. In this manner as good butter as any ever tasted has been and may be made; the flavour of the essential oils being effectually preserved. If ice is used, butter-making is much less tedious.

SHEEP.—The foundation of the Saidapet breed of sheep can be traced to a mixture of the Patna, Nellore, Mysore, and Coimbatore breeds. The proportion in which the flock was originally mixed is not known; but in 1868 there were only 11 Patna ewes in the flock of 75; two rams, however, of the same breed seem to have been largely used in crossing at that time. The flock was however nearly trebled in 1869 by the purchase of a large number of country ewes, so that the proportion of good animals was reduced; from this number the ewes were selected to form the nucleus for the flock from which the breed has since descended directly, no new blood having been introduced; the improvement which has been affected having been brought about by carefully weeding out inferior sheep and by the use of the best rams available. In fact a system of in-and-in breeding has been followed.

In the early days of the experiment, 1870, it was found that the Nellores did not thrive so well on artificial keep as the Patna and Mysore breeds; during the dry parching weather experienced in April, May and June, a considerable number of Nellore sheep died, and the whole of them were much out of condition, while the Patna and Mysore sheep, the Patnas more particularly, though grazed with the Nellores and fed on the same food, suffered very little, and were always in fair condition. A few Mysore sheep died; but very few in proportion to the number of Nellores. Of all the breeds, Nellore, Patna, Mysore, and Coimbatore, the Patna is undoubtedly the best. It comes earlier to maturity, feeds more rapidly, and gives a greater percentage of mutton.

* An ordinary atmospheric churn is referred to.

The chief characteristics of the Saidapet breed are that it comes earlier to maturity; gives a larger percentage of flesh for the food it consumes; and has a much better constitution than any known Native breed. The covering of wool is fair, but, as must be expected in these scorching plains, not of first rate quality. In 1872, it was observed regarding sheep of this breed:—

"We have produced two year old sheep, weighing from 110 to 120 pounds live weight, capable of yielding 50 lbs. of mutton, worth (at Annas 4 per lb.) 12½ Rupees; and these are from a flock of country ewes, many of which at the time the experiment commenced would not have realized 2 Rupees each in the market. Indeed nearly 100 were sold at prices ranging between 1¼ Rupees and 2 Rupees per head, some difficulty being experienced in getting even these prices."

In the next year a few sheep of this breed, which in size and form had not fully realised the expectations formed concerning them, were killed for mutton with the following results:—

——	Average Weight.	Percentage of Total.
	lb.	
Legs	10·66	24·51
Loins	15·33	35·25
Shoulders, necks, and breasts ...	17·50	40·24
Total weight mutton ...	43·49	100·00

None of these sheep had been specially fattened; they had been fed along with and in the same manner as the store sheep. They were in good average condition, their mutton being well mixed with fat, and tender. These weights are not great, indeed they could have been greatly increased had this been desirable; neither were the joints unusually heavy; the mutton was worthy of notice rather for its fine grain, its fair proportion of fat and lean, its flavor, and the large proportion of flesh to bone, than for anything else.

There are now on the Farm some excellent sheep of this breed, and, what is equally satisfactory, the sheep are perfectly hardy and quite fitted for the hottest climates. Though as the experiment proceeds the quality of the sheep will gradually improve and the good points which characterize the breed will become gradually more fixed, a good many years must yet elapse before the breed can become thoroughly established. In view to the saving of time, it would be well to procure from Northern Australia, or Southern Europe, a few rams of a short-woolled breed, in order that by judicious crossing the desired results may be hastened.

Wool production.—When the experiment was commenced, the wool yielded by most of the sheep was exceedingly coarse and almost quite straight; it is now finer and is a great deal more curled. There is, of course, very much yet to be done before the average quality of the wool will be even moderately good, but the improvement that has been effected is very encouraging.

At one time it was feared that in this hot climate but little could be done towards improving the quality of wool; but, though intense

heat is a great drawback, we possess one advantage over people resident in a cold climate in being able to grow crops throughout the year for sheep-food and this is a very important advantage in wool growing. When sheep are alternately starved and overfed, their wool is always very irregular in strength and quality, the portion produced during the period when food is scarce being always weak. As our experiments have shown that we can produce green food throughout the year, there is no reason why we should not ultimately produce fine wool; it must be remembered that some of the finest wools produced in the world are grown in countries where the temperature has a very high range, in Australia for instance.

In 1872, the following valuation of the wool of this breed was made by a professional London wool-broker.

"The two samples of wool sent to us for valuation are 'fair;' 'East Indian Yellows' worth here from 11*d.* to 11½*d.* per pound."

In comparison with the value of the wool produced in the colonies, this wool is certainly not a valuable kind, still the difference in value is not so great as might have been expected; thus, when this wool was valued, the following rates were quoted in the London Wool Market Report:—

	Ordinary per lb. s.	d.
Queensland and New South Wales ..	1	2
Victoria	1	3
Tasmania	1	3
New Zealand	1	2

The best colonial wool in unbroken fleeces was then selling at from two shillings and four pence to three shillings per pound. The rates quoted above are for wools, classed as "broken pieces and locks," to which class the wool submitted for valuation belonged.

In May 1877, when the experiment may be said to have been in operation more than nine years, the following statistics, showing the condition of the flock, were collected:—

Rams.				Ewes.			
No.	Age.	Average Weight.	Average Yield of Wool.	No.	Age.	Average Weight.	Average Yield of Wool.
38	Lambs ...	28 lb.	Not shorn.	27	Lambs ...	25·6 lb.	Not shorn.
31	Shearling ...	47 ,,	1·76 lb.	34	Shearling...	39·6 ,,	1·6 lb.
16	2 Shear ...	66 ,,	2·28 ,,	23	2 Shear ...	48 ,,	1·77 ,,
8	3 Shear ...	69·13 ,,	2·25 ,,	6	3 Shear ...	48·3 ,,	1·58 ,,
15	Aged	69·7 ,,	1·78 ,,	78	Aged ...	53·55 ,,	1·29 ,,
70	Average ...	58·74 ,,	1·94 ,,	141	Average ...	49·05 ,,	1·45 ,,
Average of 211 sheep of all ages, excepting lambs ...						52·27 lb.	1·62 lb.

It was at that time observed that "the wool produced this year shows on the whole an improvement in quality, and the sheep were far better covered, there being an absence of the bare necks and breasts that were formerly so common." The value of the wool in the local market

had increased considerably, for, instead of only $1\frac{1}{2}$ Annas per pound, the rate obtained in 1871, $2\frac{1}{2}$ Annas were realized, showing an increased value of 66 per cent. The amount of yield per sheep did not average quite as high as the clip did in 1871, when 120 sheep averaged 1·81 lb.; this being probably due in a great measure to the scarcity of grass with which the season had been characterized, whilst the number shorn was in this case nearly double.

For every ten pounds of live weight, the sheep produced on an average 4·95 ounces of wool, an amount which compares not unfavorably with that yielded by the English short-woolled breeds of sheep. The following table shows the yield of wool per ten pounds live-weight by sheep of different sexes at various ages.

——	Shearlings.	2 Shear.	3 Shear.	Aged.	Average.
	oz.	oz.	oz.	oz.	oz.
Rams	5·99	5·53	5·21	4·09	5·28
Ewes	6·46	5·90	5·23	3·85	4·73

An attempt was made in 1874 to introduce the Chinese breed of sheep, with the intention of using it for crossing on the Saidapet breed. The experiment proved that the heat of the climate is too great for the sheep of this breed, even when every care is taken to keep them from direct exposure to the heat of the sun. This result was unfortunate, as the breed possesses many valuable qualities, some of which it is desirable should be stamped on the sheep of Southern India, amongst these characteristics are a great length and depth of frame; ribs remarkably well arched; a fair yield of very fine and lustrous wool; and great prolificacy.

Management of the flock.—In the early days of the farm it was arranged that the lambing season should commence shortly after the rains, when there is an abundance of grass, but owing to the ewes consuming a large quantity of this immature succulent fodder, their milk being rendered injurious to young lambs, many deaths were caused: since then the lambing season has been made to commence at about the end of January. The management of the ewe flock is as follows; it is generally sorted over once a-year, those animals of a bad form or color, or otherwise inferior, as well as any that have lost their teeth, being taken out of the flock and put aside for fattening. In September the ewes that remain in the flock are, with a number of gimmers then about thirty months old, put with the ram; about forty ewes being placed with one: the breast of the ram is colored to mark the ewes in a way that enables the shepherd to detect readily those which have been served. The lambs are born about five months after, generally about 90 per cent. of the ewes proving to be in lamb. The ewes when about to lamb are placed in covered pens, where they are kept until their lambs are about three weeks old, after which they are again put with the flock in the sheepfold. All males that do not promise to turn out well are castrated when about six weeks old, or are sold as lambs. When about three months old the lambs are weaned from their mothers, about a fortnight's separation sufficing for this, after which the wether

and gimmer lambs are grazed in the flock with the ewes, the ram lambs being placed by themselves.

During the season of the year when night dews are heavy, the sheep do not leave the pens in the morning until the greater part of the dew has disappeared; it having been found, when the sheep were turned out too early in the morning to feed upon grass heavily covered with dew, that a number of them were invariably attacked by dysentery of a severe type. During the hottest part of the day the sheep return to the fold for a few hours, and again go to graze until about five in the evening, when they again return and receive about half a pound of ground-nut cake per head, and are shut up for the night. During very dry weather they receive, in addition to the cake, a small quantity of green food, but they are maintained chiefly by the food they gather when grazing. The sheep thus fed are kept in a thriving condition; they are, of course, not fit for the butcher, but they are generally in the condition that it is most desirable for breeding stock to be.

The sheep are generally clipped in April or May, which is the best time of the year for the purpose. When the ewes are being clipped, it is usual to mark the lambs in a way to render their identification easy; in the farm flock this is done by cutting a small notch with a pair of shears in the cartilage of one ear of each.

PIGS—have been constantly, until a quite recent date, kept on the farm, the breed having been derived from imported English pigs picked up in Madras and from ships visiting the port. If pigs receive proper attention, there is, perhaps, no more useful agricultural stock in this country, but, as generally managed by the natives, pigs are the scavengers of the villages; hence the disrepute into which country pork has fallen. It should, however, be generally known that the cattle and sheep of the ryots, when kept in a half famished state, are quite as filthy in their habits. Pigs that are properly housed and fed are almost as cleanly in their habits as cattle or sheep under similar conditions.

They are admirably suited for keeping to supply the wants of European households on coffee estates and in other places where it is almost impossible to get butcher meat fit to eat, as they can be reared under conditions quite unsuited for rearing sheep, and under artificial feeding a pound of pork can always be produced at a cost very much lower than a pound of mutton.

In 1873, the following statement, referring to four small well-fattened pigs, which shows the proportion of each kind of joint that several pigs afforded, was prepared :—

——	No. 1.	No. 2.	No. 3.	No. 4.	Average Weight.	Per cent. of Average Total Weight.
	LB.	LB.	LB.	LB.	LB.	
Legs	20	19	16	23	19·50	21·82
Loins	40	35	40	44	39·75	44·48
Shoulders	18	17	16	24	18·75	20·98
Necks and breasts ...	12½	10	14	9	11·37	12·72
Total weight of Pork...	90½	81	86	100	89·37	100·00

It will be observed that the coarser and inferior parts of these pigs (necks, breasts, &c.), weighed less than 13 per cent. of the entire weight of pork yielded by each pig; this was very satisfactory, as it proved that the pig stock at the farm had not degenerated, though it was many years since the original stock had been brought from Europe.

Originally the pigs were kept in ordinary styes floored with asphalte, the styes being provided with urine tanks; this arrangement was in operation for several years, and seemed to be as good as could be devised; however, the results never were satisfactory. The urine made ruts in the asphalte, and never passed entirely into the tanks, stagnating on the floors and causing a very offensive smell in the proximity of the styes; but the chief fault was a liability of the pigs reared in these styes to go lame, generally when about half grown; so common was this, that it was only with the utmost care that it was possible to rear a sound pig; covering the asphalte with sand or with straw was alike useless, for owing to the slope of the floors the covering always washed down from the higher level. It is difficult to explain why asphalte is thus injurious to pigs; probably, the injury, is to some extent, due to the non-absorptive property of the substance, moisture remaining a long time on its surface during damp weather, and thus generating rheumatism and similar complaints, to the attacks of which pigs are very liable.

Asphalte having been found to be unsuitable for flooring, it was determined to try the loose-box system, which had already been found to produce such good results with cattle. The results were so satisfactory that ever since pigs have always been kept in loose boxes with ordinary earthern floors. The boxes vary in area from 200 to 400 square feet; the former being the size allowed for a large sow and litter, the latter for five or six half grown sows or hogs. The roof of the shed first used in this manner was supported on brick and chunam pillars about 6 feet in height; a rail fence about 4 feet high surrounding the whole building, and the divisions or boxes being formed by partition railings. The floors were sunk about 1½ feet below the level of the surrounding ground, precautions being taken to prevent surface water from flowing in; and the eaves of the roof projected about 2 feet, so that the roof water fell clear and did not get into the bedding. At starting, a layer of ashes was spread over the floor of the box, and afterwards bedding to the depth of 5 or 6 inches. The pigs were then allowed to enter the pens. On this system in the course of a few days the bedding is trodden down to half its former height and is more or less solidified according as the pigs are large or small. It is then only necessary to add a slight surface dressing of bedding when needed. In this way both the liquid and solid manure is all retained in the straw, and the under-stratum made into an excellent manure, the surface being as clean-looking as could be desired, while there is an entire absence of smell.

At one time several of the best sows appeared to have become permanently barren, and thoughts were entertained of selling them to the butcher. Their diet was changed several times, and more exercise was given them; but no good results followed. As a last resource they were supplied daily with a few pounds of cholum fodder in a green succulent state; the results were as satisfactory as could be desired.

Probably any succulent vegetable would answer the same purpose as cholum. The only caution to observe is not to give so much green food as will cause any irregularity in the digestive organs of the animal.

Great care must be taken at certain seasons of the year to protect pigs from the sun, for they are far more liable to its injurious effects than is generally supposed. If exposed they are liable to suffer from apoplectic attacks, which very often carry them off; if taken in time the best treatment is the application of cold water.

An unsuccessful attempt was made in 1874 to introduce some Chinese pigs; for although two boars, two sows, and four young pigs of the smaller breed were received in good health, the original importations succumbed to the heat, and their cross bred progeny to a disease of the lungs.

POULTRY.—A cross between the Brahmapootra cock and Dorking hen, imported from Sydney in 1868, was highly appreciated. These fowls were widely spread over the Presidency. In appearance, they were more like the Brahmapootra than the Dorking; being about the size of the former, with generally dark grey plumage; they frequently had yellow legs, seldom but more than four toes on each foot, and were generally heavily feathered about the feet and lower part of the legs. They throve well in the plains, and during the hot season did not appear to suffer more than indigenous breeds of poultry. When properly fed they were good layers and their eggs were much larger than those of the country hen. They could be fed up to six or seven pounds weight at nine or ten months old; their flesh was good, but not quite equal to that of the Dorking.

Four chickens from one brood, when four months and three days old, averaged 4½ lb. in weight; these chickens, however, were fed on hard boiled eggs, raw meat, bran, paddy, &c., and were of a much larger size than is usually obtained under ordinary feeding. To illustrate the great importance of giving proper food to fowls, a brood of chickens was divided, one-half was fed according to the usual native custom, that is, the chickens were left pretty much to themselves, and had only an occasional hand-full of paddy or rice thrown to them; at six months old, these chickens only averaged 2¼ lb. per head; whilst the others which had been regularly fed, though only on very ordinary food, averaged nearly 4 lb. per head.

Ground-nut oil cake mixed with bran in the proportion of one to two by weight, forms a most excellent diet for fattening poultry. Fowls fatten rapidly on this food, and the flesh of those so fed is superior to the flesh of grain-fed fowls.

With the exception of some Brahma-Dorking birds given to the people of the Wudder settlement as narrated further on, it has been usual to charge the full value for poultry obtained from this farm, but if it be found possible to extend largely the practice followed in the case of the Wudders and to distribute male birds of improved breeds gratuitously to the headmen of villages under certain conditions, a great amount of good may probably be done at a very moderate cost. It is true that in many localities, from the absence of natural food during a considerable period in the year, and the neglect of the people in

providing proper food, superior breeds of poultry would degenerate, but there are many localities, in which natural food is abundant throughout the greater part of the year, that might be selected for the experiment suggested.

The experiment already referred to was commenced in 1871 in the Wudder village, at that time situated on the Farm Estate, the object being to improve the breed of fowls reared by the villagers for the market. The village contained about 150 families of Wudders, and the greater number of these kept fowls. The Wudders promised that, if a certain number of cocks of the improved breed were supplied to them, they would take great care of them and would not sell or kill them, while they would kill every cock of the country breed belonging to the village. Of this experiment it was observed in 1872:—

"They have kept their promise very fairly. There are still a few cocks of the old breed in the village, but these they promise to kill, as soon as the full number of cocks promised to them has been supplied. At first, the experiment promised to be anything but successful. Several of the first batch of birds died shortly after they came into the possession of the Wudders; for a time it was difficult to understand this; however, a little inquiry convinced me that it was entirely owing to the wretched accommodation provided for the fowls at night. I found that eight or nine, and sometimes more fowls, were confined from sunset until sunrise in a brick and mud erection measuring about 3 feet each way outside measure, and certainly not containing 8 cubic feet of space inside. This place, as soon as the fowls were put inside, was almost hermetically sealed, there being scarcely a single aperture for ventilating purposes. The dead birds presented all the appearance of having been suffocated. It was not in the least surprising that birds which had been reared with care, and which had been housed at night in a well-ventilated apartment, should be suffocated in the place provided for them by the Wudders, even though, in these same places, fowls of the country breed seemed to suffer little or nothing. However, the difficulty of getting ventilation without admitting snakes and other foes to the birds has been overcome, chiefly, I believe, by introducing a long bamboo tube in the roof of the roosting place. The fowls now appear to be thriving. There are, at the present time, about 150 chickens of the new cross. These chickens are generally light-colored, and are much larger than chickens of the country breed."

A year later on the same subject it was remarked :—

"The experiment in improving the breed of poultry in the Wudder village has not been attended with as good results during the past year as could be wished. The people cannot, or will not, separate the half-grown fowls from those that are fully grown ; the consequence is that the young hens begin to lay before they ought, which is most effective in putting a stop to any further growth. Early breeding is the great difficulty. The results of the experiment are, however, so far satisfactory that a 6-months' old half-bred fowl is as heavy as a 12-months' old country fowl. To ascertain what had been done towards improving the breed of fowls in the village, the people were asked a few months ago to exhibit their half-bred poultry at the farm yard on the Experimental Farm, a promise having been made to them that a number of small prizes would be distributed to the owners of the best birds. There were 30 entries for the competition ; these consisted of cocks 20, hens 27, chickens 20 ; total 67. Several of the birds shown were really very good. The people said that they would have been able to have exhibited a very much larger number of half-bred poultry, had not great

numbers been stolen from the village during the few weeks previous, and they added that it was only by the exercise of great watchfulness on their part that they were able to keep any of their fowls of the improved breed, as thieves were so frequently on the look out for them. They requested that they might be provided with a further supply of cocks of the European breed. As long as the people attach so much importance to early laying, we cannot effect any lasting improvement in the breed of poultry kept by them. At the time the poultry were being exhibited in competition for prizes, I was sorry to notice how anxious the people were to direct attention to what they considered valuable in the half-bred fowls, namely, their early laying propensities: one man seemed much disappointed because he did not get a prize for a fowl he exhibited, which he declared was only three months old, and yet had laid several eggs; the hen was probably a little older than the age mentioned by its owner, still it was but a chicken, and was permanently spoiled by laying so early in life. The eggs exhibited of the half-bred fowls were not so good as I had expected to see; indeed, they were but very little larger than the ordinary country eggs; however the birds which laid them were all very young, and the size of the eggs will doubtless increase as the birds get older. In size and in quality the half-bred fowls were a very decided improvement on the fowls of the country breed previously kept in the village."

Shortly after the batch of fowls, referred to above, had been inspected, a successful experiment was made to breed back from the cross to the Dorking. It seems scarcely necessary to observe that by breeding back in this way a pure bred Dorking never can be obtained, but, after a few years' successful breeding, so as to fix the type, the bird produced will so nearly resemble the pure bred Dorking that it will be impossible to distinguish it from one. By selection from a brood of chickens, which showed the characteristic marks of the Dorking, and by carefully raising their progeny, in three years a brood of fowls was established, equal in most respects to the Dorking. They were very handsome birds, and as well suited to the climate of Madras, as the indigenous fowls of the district. The color of their plumage was a silver grey, and they were as large as the birds of the Brahma cross, but much more economical for the table, as, from their shorter legs and necks, there was less of the coarser parts, while the breast and most valuable parts were heavily covered with flesh. These fowls produced much larger eggs than country fowls, while they laid quite as many; an average sized egg weighing about $2\frac{1}{4}$ oz., while an ordinary country egg only weighs about 1 oz.

The effects of the climate, however, told on the original cross-bred fowls imported, and, after seven or eight years, they had so degenerated that it was considered advisable to obtain a fresh supply from Australia: the fowls of the second batch were, however, very inferior to those previously imported. At the same time some Aylesbury ducks were obtained, and during the same year (1875) a batch of ducks was obtained from Pekin. The latter reached Madras in excellent health; the breed is a very fine one, the birds being more like small geese than ducks. These ducks have been perfectly healthy since they arrived at the farm; they are very prolific layers, and their eggs are large, some weighing as much as 3 oz.; however, after laying almost continuously for nearly six months they stopped, and have not again

commenced to lay to any extent, the extreme heat having apparently been too great for them, although their health has been good. Some average-sized eggs from these importations weighed as below:—

—	Weight.	Average Weight per Egg.
	oz.	oz.
7 Pekin duck eggs	19·03	2·71
5 Aylesbury duck eggs	9·74	1·94
8 Brahma-dorking fowls' eggs ..	13·73	1·71

CHAPTER VI.

FOODS AND FEEDING.

FEEDING.—In selecting food for any kind of stock, the species and age of the animal to be fed and the object with which it is being fed must be remembered. Thus, the ox can digest more woody fibre in a food than the sheep, whilst the pig seems to be incapable of digesting it at all; cattle from the size of their stomachs require a bulky food and a considerable amount of water; sheep, on the contrary, do not require so large a volume of food, nor do they require so much water, in proportion to their size. Artificial foods, whilst they are most valuable auxiliaries, should not alone constitute the food of sheep. The pig has been proved to make the most use of his food in assimilating it into his structure, and thus fattens easily and quickly, and repays the use of rich foods. If animals are young and in a growing state they require a larger and more concentrated supply of food for their size than older animals; they require a more highly nitrogenized food for the development of their tissues; and they extract from food a larger amount of its mineral constituents for the formation of their bones, &c. In fattening cattle and sheep, when the wear and tear is reduced to a minimum and the object is to increase the amount of flesh and fat, substances rich in oil, starch, gum, sugar, &c., produce the best results. Milch cattle should always be liberally fed with green fodder, as it causes an increase in the quantity of the milk produced; if the production of butter be the object in view, the use of foods containing a high percentage of oily matters has an effect in increasing the amount; should cheese be the desideratum, the use of leguminous crops, such as gram, owing to the fact that cheese is chiefly composed of casein (the nitrogenous part of milk), will cause an increase of the constituent required.

PASTURE.—In Southern India natural pasture is generally very poor, the natural grasses being all, as far as is known, harsh, coarse and wiry. The pasture lands are most unevenly distributed and no endeavours are ever made to improve them. The growth of forage crops is a branch of husbandry ignored, if known, and at any rate unpractised; fodder raising is however a remunerative branch of agriculture, although the profits from it are not to be immediately counted out in rupees; but are to be found in the larger supplies of organic manure so much required in this famine-stricken land, in the greater number, the better health, the earlier maturity, fuller development, greater power, and stronger constitutions of the livestock.

Artificial, that is specially cultivated grasses are never grown, although an unrivalled one exists in guinea-grass; whilst the Indian cultivator possesses a variety of fodder crops such as would delight the

heart of agriculturists in less favored countries. While the agriculturists of this country have so long recognized the advantage of folding sheep at night on arable land, it is strange that the importance of providing green food for their consumption on the land has not long ere this been recognized. There is nothing in the practice, that is prejudicial to caste, or noxious to their feelings.

Fodders.—To test the proportionate feeding value of the fodders mentioned, the experiment recorded below was made with four bullocks, aged from four to six years, in loose boxes. The animals received as much green food as they could consume, the same quantity of corn and cake being given to each; the following were the results:—

Dates of Weighing.	Bullock fed on Cholum Fodder.	Bullock fed on Grass.	Bullock fed on Guinea-grass.	Bullock fed on Gram Fodder.
	LB.	LB.	LB.	LB.
February 2nd ...	343	384	287	360
Do. 12th ...	340	406	304	375
Do. 22nd ...	335	415	310	375
March 4th ...	359	423	315	385
Do. 14th ...	367	431	329	396
Do. 24th ...	383	430	331	403
Increase ...	40 lb., or 12 per cent.	46 lb., or 12 per cent.	44 lb., or 15 per cent.	43 lb., or 12 per cent.
Comparative cost of fodder.	25	100	70	30

The result from guinea-grass is probably larger than will generally be obtained, guinea-grass has never again given such returns.

An idea is prevalent amongst the ryots of this neighbourhood that cattle will not eat cumboo straw. They certainly do not care for the dry cumboo straw which has matured its grain; but they are quite as fond of it in the green state as they are of green cholum and other green fodders. The following experiment was made with green cholum and green cumboo straw:—

Date of Weighing.	Bullock fed on Green Cumboo Fodder.	Bullock fed on Green Cholum Fodder.
	LB.	LB.
July 18th	302	214
Do. 28th	310	217
Increase	8	3

This experiment was conducted over much too short a period to produce results of any practical value. It however proved, what further experience has confirmed, that not only will cattle eat green cumboo fodder, but that they will thrive upon it.

The following experiment was made to determine the value of gram fodder, in comparison with the grass usually cut for horses, and cholum fodder. Three lots, each lot containing the same number of

sheep, were put up to feed, and weighed at the end of every ten days. Each lot received the same quantity of corn and cake and as much green food as the animals could consume. The results were :—

Date of Weighing.	Average Weight of Sheep fed on Cholum Fodder.	Average Weight of Sheep fed on Grass.	Average Weight of Sheep fed on Gram Fodder.
1870.	LB.	LB.	LB.
February 2nd	39·8	40·0	39·8
Do. 12th	40·6	40·0	40·6
Do. 22nd	42·0	39·2	42·5
March 4th	43·4	41·4	43·4
Do. 14th	45·2	44·8	45·2
Do. 24th	46·0	45·8	47·5
Increase	6·2 lb., or 15·5 per cent.	5·8 lb., or 14·5 per cent.	7·7 lb., or 19·3 per cent.

The feeding value of some paddy fodder, grown at a cost of Rupees 2-6-7 per ton, was tested against that of grass, such as is usually provided by grass-cutters, grown on a similar soil as follows :—Of a selected pair of working cattle, one animal was fed on the grass alluded to, and the other on paddy fodder; each forage was given at the rate of 30 pounds per head, and each animal received in addition 4 lb. of oil cake. They were weighed at the end of every seven days, with the following results :—

—	1st Weighing.	2nd Weighing.	3rd Weighing.	4th Weighing.	5th Weighing.	6th Weighing.	7th Weighing.	8th Weighing.	9th Weighing.	10th Weighing.	Increase. Total.	Increase. Per cent.
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
Animal fed on paddy fodder	784	826	836	846	850	860	854	882	876	870	86	10·9
Do. on grass ...	870	870	840	835	842	868	852	864	861	895	25	2·8

A similar experiment was made with sheep. Four full grown store sheep were selected, and placed in two pens, two in each. Those in Pen No. 1 received daily 15 lb. of paddy fodder, 2 lb. of oil cake, and 2 lb. of tour; those in Pen No. 2 received daily 15 lb. of ordinary grass, 2 lb. of oil cake, and 2 lb. of tour. The sheep in both pens were weighed at the end of every seven days. The weighings were as follow :—

—	1st Weighing.	2nd Weighing.	3rd Weighing.	4th Weighing.	5th Weighing.	6th Weighing.	7th Weighing.	8th Weighing.	9th Weighing.	10th Weighing.	Increase. Total.	Increase. Per cent.
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
Sheep fed on paddy fodder	172	180	185	186	178	177	179	178	186	188	16	9·3
Do. fed on grass ...	154	166	166	166	167	155	160	160	163	167	13	8·4

Other experiments have been made, the results of which agreed generally with those of these experiments. The results appear to be slightly in favor of the paddy fodder grown under average circumstances. It is weight for weight, as nutritious as the grass, which is almost universally used in this part of India for feeding horses. Paddy fodder can be made into hay, for which purpose it is as well suited as the oat, which in some countries is largely so used. It is perhaps rather too coarse a food for horses, excepting for those employed at slow work only ; but for cattle, either for draught or for dairy purposes it is well adapted; although as a food for dairy stock it is not as good as cholum fodder as the following proves:—A milch cow, consuming daily 45 lb. of cholum fodder yielded three measures of milk per diem, when paddy fodder was substituted, though a similar weight was consumed, the yield of milk was reduced to two measures, but when feeding with cholum fodder was again resumed, the daily yield of milk rose to the quantity obtained previous to the change of food.

It must be remembered that the nutritious value of any fodder will much depend on the fertility and condition of the soil which produced it. A soil, that is naturally rich or that has been highly manured, will yield a more nutritious fodder than one which is in a more or less impoverished condition.

Artificial Foods.—In the following table, the analyses of some of the principal pulses of this country are given; they are published on the authority of Professor Church, of the Royal Agricultural College :—

Common Name	Dholl.	Green Gram.	Black Gram.	Mochecottay.		Horse-gram.
Botanical Name	Cajanus Indicus.	Phaseolus Mungo.	Phaseolus Rox-burghii.	Lablab vulgaris (Brown.)	Lablab vulgaris (White).	Dolichos uni-florus.
Moisture	13·30	10·80	10·10	14·60	14·30	11·00
Oil	2·60	2·65	2·15	2·25	2·20	1·95
Albuminoids	17·09	22·15	22·72	17·09	20·54	20·95
Starch and digestible carbo-hydrates	55·73	54·20	55·83	57·51	53·51	56·72
Indigestible fibre	7·53	5·80	4·80	5·00	5·80	6·16
Ash	3·75	4·40	4·40	3·55	3·65	3·22
	100·00	100·00	100·00	100·00	100·00	100·00

In the early days of the farm, besides fodder, horse-gram was the chief food of the cattle. The usual manner of preparing gram by boiling was soon found to be inferior to steeping only ; for, quite independent of the fact that boiling renders the albumen of the gram insoluble and therefore less digestible, the cells of the pulse are generally violently ruptured during the boiling process, and a large quantity of soluble nutritious matters are set free ; these are lost in the water, and go to form the soup which is always misappropriated by the coolies. In order to determine the merits of the two methods, the following experiment was made :—

A lot of sixteen draught cattle, similarly worked, was equally divided. One lot was fed daily on 12 lb. of boiled gram and 12 lb. of ground-nut cake, while the other lot received daily 12 lb. of steeped gram and 12 lb. of ground-nut cake. The results were as follow :—

—	The Animals fed on boiled Gram.	The Animals fed on steeped Gram.
	LB.	LB.
Weighed at the commencement of the experiment.	6,339	6,310
Twenty-seven days afterwards they weighed ...	6,576	6,576
Showing an increase of	237	266
Percentage increase	3·74	4·22

The substitution of steeping for boiling in the preparation of gram as food for horses has been tried in many stables, but the results have not generally been satisfactory ; some horses eating it readily but others altogether refusing it. As a general rule recently imported horses eat it better than horses which for years have been fed on boiled gram ; and as most of the horses in this part of India are imported from countries in which this pulse is unknown, it would, on their first arrival, be as easy to accustom them to steeped as to boiled gram.

Ground-nut Cake.—It was discovered at an early date, however, that it was more economical to use only ground-nut oil cake for cattle food than gram. This cake is the refuse obtained in the manufacture of oil from the seeds produced in the underground pods of the *Arachis hypogœa* ; a plant, belonging to the natural order of Leguminosæ, that is grown very largely in many parts of this Presidency as an ordinary field crop.

The oil of the ground-nut is highly valued in Europe; indeed, it is generally quoted at a price from 10 to 15 per cent. higher than the best linseed oil; it is said to be largely used as a substitute for olive oil, and that it is chiefly used for preserving sardines.

The cake met with here is always made from decorticated seed ; the husks are used as fuel, and the ashes therefrom, which amount to ·7 per cent. of the total crop, are generally thrown away ; which, as the following extract shows, is a most wasteful practice :—

"The ash of the seed consists of salts wholly soluble in water, they being phosphates of the alkalies, with traces of alkaline chlorides and sulphates. The phosphoric acid is chiefly united with potassa. The ash of the husk differs in containing chiefly common salt, and phosphates of lime and magnesia."

The value of the cake as a feeding stuff has been clearly shown, both by experiment and by scientific reasoning. The following analyses of this oil-cake are interesting :—

Constituents.	Professor Church. Decorticated.	Professor Church. Undecorticated.	Professor Tuson. Decorticated.	Professor Tuson. Undecorticated.	Dr. Vœlcker.	Dr. Anderson. Average of two.	Average Composition of Linseed Cake.
Moisture	9·3	8·1	9·58	9·28	10·80	10·84	12·0
Oil	5·6	8·8	7·40	6·99	8·12	9·80	11·5
Albuminoids	43·4	30·5	42·81	32·81	28·62	30·33	29·7
Carbo-hydrates ...	31·4	27·8	27·63	23·67	18·86	} 45·50	{ 27·8
Indigestible fibre ...	5·2	19·1	7·87	23·80	29·09		12·0
Ash	5·2	5·7	4·71	3·45	*4·51	†3·53	‡7·0

Judging from the analyses given by Professors Church and Tuson of cakes made when the seed is husked and unhusked, those of Dr. Vœlcker and Dr. Anderson referred to samples of undecorticated cake. Comparing the analyses with that of a sample of linseed oil-cake, given by Dr. Vœlcker, the cake will be seen to be not quite so rich in oil and therefore not so well adapted for fattening purposes as that cake; but, as the means of expressing the oil from the seed in this country are very inadequate, in all probability the percentage of oil here is much higher, so that this objection disappears; the high percentage of nitrogenous matters explains why the cake is so useful a food for working cattle.

It may be well to observe that the high percentage of nitrogenous compounds in the cake causes a great increase in the value of the manure made by animals fed on it; for it is calculated by the best authority on the subject, Mr. J. B. Lawes, of Rothamstead, that the loss of nitrogen in the consumption of cake is about one-tenth of that which it contains, the rest passing off in the manure.

Experiment has proved that working cattle will keep in better condition when fed on ground-nut cake alone, than when fed exclusively on horse-gram, as follows:—

—	Cattle fed on Ground-nut Cake.	Cattle fed on Horse-gram.
	LB.	LB.
First weighing	2,737	3,097
Last weighing twenty-seven days afterwards ...	2,733	3,070

As a food for horses, this cake is extremely valuable. It is only necessary to remember that, weight for weight, it is as nutritious as gram, and that in most seasons, it can be purchased at half the price of gram, to ascertain at once the saving that would be effected by substituting cake for gram; however, in feeding horses this is not recommended.

* Containing sand 1·4. † Containing phosphates 1·15, phosphoric acid ·80.
‡ Containing potash 1·65, phosphate of lime 4·92.

It is, for such a purpose a better plan to deduct one-half the usual allowance of gram, and to replace this by cake. In this way a saving of 25 per cent. could be effected in the cost of the food of every horse now fed on gram, while the condition of the animals would be improved. A Pegu pony, which formerly received daily $2\frac{1}{2}$ measures of gram (uncooked) and was never in good condition, was fed for 18 months on the following daily allowance :—

1 measure of gram, (uncooked)
2 lb. of ground-nut cake,

and kept in excellent condition. Under the old method of feeding, his gram at ordinary prices cost monthly Rupees 5-14-2; the food substituted only cost Rupees 3-1-8 per mensem.

Several experiments have been made to test the comparative feeding values of maize and horse-gram. In one case two pairs of working cattle were selected, one animal from each pair being fed similarly in order to ensure that the work performed should be equal. Each pair received 5 lb. of tour, and 100 lb. of cholum fodder per diem, in addition, in one case to 6 lb. of gram, and in the other to 6 lb. of maize. The results obtained were as follows :—

——	February 2nd.	February 12th.	February 22nd.	March 4th.	March 14th.	March 24th.	Increase.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Weight of the pair fed on maize.	1,762	1,765	1,799	1,806	1,806	1,823	127
Weight of the pair fed on gram.	1,765	1,789	1,767	1,759	1,786	1,768	3

Thus showing that weight for weight maize is superior to gram as a food for working cattle. On another occasion two lots of six wethers each were fed for slaughter; both lots receiving as much gram fodder as the animals would eat, whilst to one 3 lb. bran and 6 lb. maize, and to the other 3 lb. bran and 6 lb. gram were given daily. The results were as follows :—

Date of Weighings.	Average Weight per head of Sheep fed on Gram.	Average Weight per head of Sheep fed on Maize.
	lb.	lb.
February 2nd	38·75	37
Do. 12th	39	37·33
Do. 22nd	40·83	37·33
March 4th	43·83	39·66
Do. 14th	44·33	42·80
Do. 24th	45	45
Increase	6·25	8
Increase per cent. ..	16·13	21·62

As in the case of the cattle experiment, so in this case the maize was novel to the animals, and was not eaten readily during the early part of the experiment. However, as soon as the animals got to like it they made greater progress than those on gram, and the results are very satisfactory. In all probability had the maize and gram been crushed and mixed together before being given to the animals, the result would have been better, for gram and maize serve different purposes in the animal economy; the former being a nitrogenous or flesh producing, the latter a carbonaceous or heat producing food.

MANUFACTURE OF MEAT.—The following experiment was made to ascertain the relative value of ground-nut cake and maize as food for fattening pigs, and to discover also the cost of producing a pound of pork. Four young pigs, nearly equal in age and in size, were selected; they were placed in loose boxes, two in each; those in Pen No. 1 being fed on 4 lb. of ground-nut oil cake and 4 lb. of tour, and those in No. 2 Pen on 4 lb. of maize and 4 lb. of tour, daily. Besides these foods a quantity of green fodder was thrown into each pen two or three times a day, all the pigs getting a similar supply. The pigs were weighed at the end of every week with the following results:—

—		1st Weighing.	2nd Weighing.	3rd Weighing.	4th Weighing.	5th Weighing.	6th Weighing.	7th Weighing.	8th Weighing.	9th Weighing.	Increase.	Pork.	Cost of food.	Cost of Pork per lb.
		lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	RS. A. P.	RS. A. P.
No. 1 Pen.	Two pigs fed on cake and tour.	236	254	257	257	267	280	314	323	335	99	$59\frac{1}{4}$	4 6 1	0 1 4
No. 2 Pen.	Two pigs fed on maize and tour.	255	254	265	270	282	307	320	330	344	89	$53\frac{1}{4}$	7 5 7	0 2 2

Thus not only is ground-nut cake weight for weight superior to maize for making pork, but also, with the price of the former at 85 lb. per rupee, and the latter at 40 lb. per rupee, 38 per cent. cheaper food.

The following is a small experiment made to determine the cost of producing a pound of beef, and, although partially injured by disease checking the natural increase, the data collected during the thirty-five days after the disappearance of it are valuable. Two bullocks, which weighed together 692 lb. at the commencement of the experiment, were allowed daily 6 lb. of ground-nut oil-cake and as much fodder as they chose to eat, which amounted to about 50 lb. In thirty-five days they increased 108 lb. in weight; estimating that this increase in their live weight would yield about 42 per cent. beef, the proportion which the

cattle of this country are usually found to yield when fairly fattened, the increase will represent about 45 lb. of beef at the following cost of feeding :—

	RS.	A.	P.
Ground-nut oil-cake for 35 days, at 6 lb. per day, valued at 7 rupees per 500 lb. ..	2	15	0
Fodder for 35 days, at 50 lb. per day, valued at 1 rupee for 400 lb.	4	6	0
Attendance, &c.	0	11	0
Total 45 lb. of Beef at 2 annas 10 pies per lb. = Rs. ..	8	0	0

The value of the manure would more than equal the cost of the straw required for bedding, the value of the accommodation, &c.

In another experiment after sixteen weeks' feeding on horsegram a bullock increased in weight 125 lb., which would yield about 52 lb. of beef; the cost being as follows :—

	RS.	A.	P.
Gram, 3 lb. per day, for 112 days, valued at 36 lb. per rupee	9	5	4
Fodder, 30 lb. per day, for 112 days ..	8	6	4
Attendance, &c.	2	0	0
Total 52 lb. of Beef at 6 annas 1 pie = Rs. ..	19	11	8

An experiment was made in feeding a "lot" of bullocks, which were purchased at Rupees 15 each. The charges made for food include the cost of chaffing, crushing, and preparing it. The charge under the column headed "Attendance, &c.," is composed of a monthly charge of 6 annas per head for attendance, &c., and 2 annas per head to pay interest, &c., on the cost of the cattle box: one man, at 5 rupees per month, can easily attend to fifteen feeding cattle: the loose boxes cost each about twelve rupees. With one exception the cattle were all slaughtered and sold on the Farm. The average price obtained for the beef was 4 annas per pound. One-fifth of the cost of cake, corn, and bran, &c., is credited for manure. The following are the results :—

When feeding commenced.		When killed.				Food consumed.						Expenditure.			Receipts.			
Date.	Live Weight.	Date.	Live Weight.	Produced. Pounds of Beef.	Produced. Per cent. of Beef.	Maize.	Tour.	Bran.	Ground-nut Cake.	Cholum Straw.	Paddy Straw.	Cost of Food.	Cost of Attendance, &c.	Total Cost.	Sum realized for Beef.	Value of Manure.	Total Receipts.	Profit.
	lb.		lb.	lb.		lb.	lb.	lb.	lb.	lb.	lb.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
Feb. 26th...	476	June 18th...	523	219½	42·6	183	...	...	178	1,108	850	17 13 8	2 0 0	34 13 8	48 6 9	1 7 4	49 14 1	15 0 5
Do. 26th...	484	May 21st...	516	214½	41·47	120	...	...	120	903	545	12 1 8	1 8 0	28 9 8	48 3 0	0 15 6	49 2 6	20 8 10
Do. 26th...	457	Do. 7th...	...	221	...	...	...	101	96	800	416	9 8 7	1 4 0	25 12 7	48 15 6	0 11 9	49 11 3	23 14 8
Do. 26th...	410	Jan. 1st...	...	264	...	...	90	498	716	3,388	1,224	46 5 7	5 0 0	66 5 7	63 11 6	5 4 4	68 15 10	2 10 3
Do. 26th...	516	June 4th...	570	244¼	42·98	157	16	136	...	1,042	776	15 6 0	1 12 0	32 2 0	51 3 0	1 2 0	52 5 0	20 3 0
Do. 26th...	376	July 6th...	Sold alive		...	216	80	141	...	1,298	1,000	21 1 8	2 4 0	38 5 8	45 0 0	1 11 9	46 11 9	8 6 1

Many experiments have been made in sheep-fattening, amongst others the following:—

Number of Sheep.	Weight at commencement.		Average duration of Experiment.	Live Weight on day of Slaughter.	Produced		Purchased Food consumed.				Expenditure.				Receipts.			
	Total.	Average.			Net Weight of Mutton.	Per cent. of Mutton.	Gram.	Bran.	Cotton Seed.	Oil Cake.	Cost of Sheep.	Cost of Corn and Cake.	Cost of other Food, Attendance, &c.	Total Cost.	Value of Manure.	Price realized.	Total Returns.	Profit.
No.	lb.	lb.	Days.	lb.	lb.		lb.	lb.	lb.	lb.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
8	512	64	116	600	211¼	45	444	222	338	..	32 0 0	21 12 0	5 0 0	58 12 3	5 7 0	69 13 0	75 4 0	16 8 0
12	600	50	139	732	312	43	810	435	...	548	36 0 0	37 4 0	8 8 0	81 12 0	9 5 0	81 14 0	91 3 0	9 7 0
12	528	44	199	708	310	44	1,070	615	780	...	30 0 0	44 4 0	9 8 0	83 12 0	11 1 0	79 9 0	90 10 0	6 14 0
11	514	46	203	754	337	45	1,244	612	...	816	27 8 0	55 9 0	9 0 0	92 1 0	13 14 0	84 0 0	97 14 0	5 13 0
12	556	46	171	698	345	49	1,032	516	688	...	30 0 0	42 0 0	9 0 0	81 0 0	10 8 0	86 4 0	96 12 0	15 12 0
12	560	47	171	792	356	45	1,032	516	...	688	30 0 0	46 9 0	9 0 0	85 9 0	11 10 0	89 0 0	100 10 0	15 1 0

The following figures show how results may vary with the kind of animal selected for fattening. Two bullocks very similar in general appearance were chosen; both animals were similarly fed, the daily food of each consisting of 3 lb. of horse-gram and as much fodder as it could consume, about 30 lb.; the animals were weighed at the end of each week as the experiment progressed, with the following results:—

—	Bullock No. 1.	Bullock No. 2.
	lb.	lb.
1st Week	378	390
2nd do.	388	408
3rd do.	396	402
4th do.	416	390
5th do.	396	378
6th do.	406	395
7th do.	420	398
8th do.	413	395
9th do.	419	390
10th do.	427	399
11th do.	429	395
12th do.	456	396
13th do.	470	397
Total increase ...	92	7
Increase per cent. ...	24	2

This experment is instructive in showing how differently two animals will progress and lay on flesh, even when fed with exactly the same food and under exactly similar conditions. This fact is well known to feeders in England, who will frequently readily give from ten shillings to one pound a head more for cattle from one part of the country than for those from another part, though the cattle for which the higher price is given may in no respect look better than those which are less appreciated.

Chaffing.—The practice of chaffing fodder for cattle has been regularly practised with the best results. It is a most economical arrangement in preventing the waste, which always occurs when cattle are fed on long straw. It also enables cattle to be kept in good condition on a smaller allowance of food, as they do not tread into the manure any appreciable amount of chaff; and also as their food is in a finer state of division, the cattle are able to assimilate more of what they eat.

In conclusion it may be well to observe that, in the present state of the social customs of the country, it will scarcely be necessary to prosecute fattening experiments to any extent, it having been proved that both beef, mutton, and pork can be raised at remunerative rates; the value of ground-nut cake is incontestable, and the comparative value for feeding of a grass very easily grown—guinea grass—has been clearly demonstrated; as well as that of several other fodders; steeped gram has been shown to be productive of better results than boiled, whilst maize is superior as a food to either. There, however, yet remain many questions to be solved before feeding in India can be reduced to the science it is in England.

CHAPTER VII.

IMPLEMENTS, MACHINES AND TOOLS.

The Indian farmer, as is well known, places but little trust in implements, he possess one which is called a plough, but which is in reality a very badly constructed cultivator or scarifier; this implement can be made for about a rupee and a half by any one, so that in embarking in an agricultural enterprise the ryot does not, like his European fellow-toiler, lock up any considerable amount of capital in the means of preparing the soil for the reception of his crops. But in no way does the ryot show his blindness to his own true interests more clearly than in his adherence to his ancestral crooked stick, which he uses with so much ill-directed energy in scratching the soil which he has treated so ill, and which even to his illiberal management yields returns so disproportionately good.

PLOUGHS.—On the farm for ten years Ransome and Sim's, and Howard's ploughs have been in constant use; both large and small ploughs have been employed, the former being found useful when the ground is so dry and hard that a light plough cannot penetrate it. Cattle and coolies work them well. The coolies readily learn the use of the plough, some are very good ploughmen, and are as proud of their skill as any English ploughman; indeed, some of them will turn as straight and regular a furrow as was ever seen in any champion ploughing match at home. A remarkable change has taken place in the observations of the ryots who come to see our operations; at first one of their greatest objections to our ploughs was that they ploughed too deep; but the chief one they now advance against them is their great cost in comparison with native ploughs. The seeming force of this objection will be better appreciated when it is stated that twenty or twenty-five native ploughs can be purchased for the price asked for one of our English ploughs.

It, however, will be allowed that the question for the consideration of the ryot, when about to buy a plough, is not so much the price that must be paid for it, as the cost of the work that the implement will perform: thus, if he can with an iron plough, making every allowance for labor, keep of cattle, for wear and tear, interest, &c., turn over his soil at the rate of sixty cubic yards for an anna, while with the country implement the cost of doing the same work is not less than two annas, it is evident that the extra cost of the iron plough will be recovered in a very little time on a farm of moderate size; indeed, the ryot who cultivates a holding with but 20 acres of arable land can, by substituting an iron for his native plough, save in a single season a sum equal to its first cost, and it will, with ordinary care, last many years. It has been found that for effect one English plough can do better work than three or four

native ones; so that allowing for a slightly better description of cattle being required for the former, it is evident that by being relieved of the expense of keeping up an extra two or three pair of draught bullocks, and of the pay of two or three coolies to drive them, the ryot would affect a saving such as has been pointed out; the difference in cost of up-keep of a good and of an inferior pair of cattle not being great.

It is well known that the native implement cuts a triangular groove, while the furrow made by the English plough is rectangular; the result is that while the latter cleans out its furrow and leaves the undersurface level at one operation, the former leaves a ridged undersurface with nearly half of the land unmoved. It is also known that the English plough inverts the soil and brings up each time a fresh surface, while the native "cultivator," as it should be called, leaves the soil in its original position. These facts explain the necessity for the ryot, in using his own implement, to go over his land again and again before he can be assured that the whole surface soil has been disturbed; treading at the same time the immediate subsoil into a "pan" impervious to water and presenting a barrier to the roots of plants, when searching downwards for food and water. The native implement is unable also to perform several operations which the English plough can.

The ease with which the English plough can be made or repaired by native blacksmiths has been abundantly proved on the farm; in the workshops attached to which, ploughs of different descriptions are constantly being manufactured by men, who, before they were taken into the shops, never saw a real plough. The castings so often used at home must of course be avoided, but that is easily done.

In the following table the results of some experiments made with several ploughs are given :—

Description of Plough.	Price.	Depth of Furrow.	Width of Furrow.	Draught.	Soil moved in 100 Yards run.	Travelled in ploughing 1 Acre.
	RS.	Inches.	Inches.	LB.	Cub. Yds.	Miles.
Howard's plough	35	4	8	184	2·47	12·37
		6	9	308	4·17	11
Ransome's New-Castle plough.	90	4	10	280	3·09	9·9
		6	10	406	4·63	9·9
Native plough	1·½	5	Surface 6 Sole 1	140	1·35	28·29
Combined plough ..	18	4	8	182	2·47	12·37
		6	9	280	4·17	11
In puddle for paddy.						
Combined plough ..	..	6	9	168	4·17	11
Native do. ..	..	6	Surface 6 Sole 3	200	2·08	22

The plough first mentioned is that which is recommended especially for its general utility; although recently a plough imported from Sweden, of

stronger make, and costing about two-thirds of the price only, has been experimented with, and though rather less efficient is perhaps better adapted for use in this country. The New-castle plough is very useful during dry weather, when light ploughs will not penetrate the ground; this plough weighs 200 lb., and though much too heavy for ordinary work, is nevertheless very useful in ploughing stubbles after harvest.

The Combined plough.—is a swing plough with wooden stilts and pole, the remainder being composed of malleable iron; it weighs only 70 lb., and can be carried from field to field, and whilst in work the driver is always close to his cattle; in preparing small fields for the paddy crop the plough is particularly useful. As is shown by the concluding portion of the table given above, the very defective construction of the native plough adds greatly to its draught; for in the hinder part of the plough there is a flat surface measuring eight or ten inches square placed at right angles to the line of draught; this not only offers a great deal of resistance to the passage of the plough through the soil, but in paddy land such an amount of mud collects on it, and in the angle below the pole, that the plough is drawn through the land with great difficulty. This is not the case with a plough provided with an English shaped mould-board, this mould-board presenting no points for the accumulation of mud, the plough cleans itself as it proceeds.

Although experience has clearly shown that in adopting the English plough the ryot will follow the course most beneficial to his own interests and to those of the country, experiments have been made to remove, by simple alterations, some of the greatest defects of construction in the native implement. The dead weight of the native plough is extraordinarily little, but its draught is enormous; on one occasion it was found that:—

1. An ordinary native plough, the dead weight of which was only 32 pounds, needed a force equal to 390 pounds to drag it through the soil when working
2. An ordinary native plough, with some slight improvements, the chief of which was the removal of the upright flat surface behind the share by cutting down both sides, the dead weight of it then being 36½ pounds required a force to drag it when working of 336 pounds.
3. An ordinary native plough, improved as in No. 2 experiment, and fitted with a wooden mould-board, the dead weight being 56 pounds, required for dragging it when working a force equal to 280 pounds only.

In these experiments all the three ploughs were doing the same amount of work, viz., moving 2 cubic yards of earth in each 100 yards of furrow, and were all dragged in an uniform way by coolies. It will be observed that the improvements made materially lessened the draught; it is also worthy of notice that the heaviest plough did its work with an expenditure of nearly thirty per cent. less force than the plough which was only about half its weight.

It is scarcely probable that a plough will ever be made that will be able to penetrate soil in the dry season, which has been undisturbed for

some months; but some American ploughs, imported from Boston in 1872, were found to work well, when the soil was a little too hard to be ploughed with any ordinary English plough, in spite of the hardness of the ground. They are very clumsy-looking implements, and are certainly transported over the farm with difficulty, but their working parts are admirably adapted for contending with rough work. The following table gives a comparison of their working capabilities, with that of the ploughs generally in use :—

Description of Plough.	Dead Weight.	Draught.	Work done. Furrow. Depth.	Furrow. Width.	Soil moved in each 100 Yards run.
	lb.	lb.	Inches.	Inches.	C. Yds.
American plough	90	330	6	11	5·09
Ransome's Pony plough ...	92	280	5	9	3·47
Howard's do. do. ...	86	330	7	8	4·32
Combined plough ...	67	290	5·5	8	3·39

In 1875 two small ploughs were imported from America: one, a small cast-iron plough intended to be drawn by one horse or mule for use in cotton culture; the other, a steel plough differing only from the former in having a steel mould-board with a polished cast-iron share and land side, the mould-board also being less abrupt. In both cases the beams and stilts are wooden, and the general construction is not good for ordinary work; the mould-boards are set nearly at right angles to the beam, thus causing the draught to be very heavy; and the slades are so short that the ploughs move very unevenly through the soil, in places going so deeply that they become fixed; by placing a wheel under the beam the latter drawback has been avoided, and a slight alteration in the form of the mould-board would greatly reduce the draught. The cast-iron working-parts, also, are objectionable; they are so liable to be broken when in use by coming into contact with stones or the roots of trees. Implements that are fitted with working-parts made of cast-iron are not yet suited for general use in this country; much annoyance and loss have already been experienced from the purchase of such implements.

The following results were obtained in an experiment made to test the working capabilities of these ploughs :—

——	Weight of Plough.	Draught.	Work Done. Furrow. Depth.	Furrow. Width.	Earth moved in each 100 Yards run.	Price Delivered in Madras.
	lb.	lb.	Inches.	Inches.	C. Yds.	RS.
Steel plough...	45	280	7	11·	5·94	18
Cast plough...	34	448	9	13·53	9·39	10

Were it not for its excessive draught the "cast" plough might have been a valuable introduction; a modification of the former has been made in the farm Workshops at a cost of about Rupees 20.

One of Ransome's turn-wrest pony ploughs has been in use; when employed for cultivating between the rows of cotton, maize, sorghum, &c., it performs its work in a satisfactory manner, and the draught is very low. Turn-wrest ploughs are specially intended for use on the slopes of hills, on which it is desirable to throw the furrow slice on one side only; for this purpose the mould-board is reversible; still they are well suited for use as ordinary ploughs on level land for cultivating, &c., and possess an advantage over the plough of ordinary make, for when the mould-board is worn near the sole, it can be reversed, and the upper portion brought into use, thus performing the part of a new mould-board. These ploughs are made entirely of iron, and are well suited for coffee or tea plantations, where the slope is not too great. They can be worked with a single bullock, pony, or mule, thus avoiding the use of swingle-trees, which would do much damage amongst tea and coffee bushes. The full-sized turn-wrest ploughs now used in England are much superior in their construction to the implement referred to here.

In 1877 a number of ploughs of Swedish manufacture were received from the Secretary of State; on trial they were not found to be quite so efficient as those of English make, but still, being much cheaper and of a stronger make, several of them have a good deal to recommend them for introduction into this country. Pattern No. 39 gave slightly better results than a plough of Ransome's; its cost, delivered in Madras is about 12 per cent. less and its make considerably stronger than the latter. Pattern No. 40 also can be recommended. Pattern No. 29 is peculiar in having only one stilt; it gave results but very little inferior to Ransome's plough, and its cost in Madras is under Rupees 25, Ransome's plough costing about Rupees 40; it is well adapted for use on the prevalent light and medium soils of Southern India.

Resembling the native plough in some degree in its action, but in nothing else, is a very valuable implement for the light land farmer—the *Grubber* or *Scarifier*. It is doubtful whether for naturally open soils it would not be better policy for the farmer to use a scarifier in general, leaving his ploughs alone, excepting for the occasional and most necessary process of deep cultivation; when once in a season the land has been stirred to the full depth intended, probably, unless the soil has the bad quality of running together on the first fall of rain, like that of the farm, it would be advantageous to use a grubber only. For this purpose it might be said that the native plough is adapted; but that is a fallacy, for it is one of the most inefficient scarifiers imaginable and even, after it has crossed and recrossed a field three or four times, parts are still left untouched, unmoved, whilst with a good grubber one, or at the utmost on dirty or hard land two turns will suffice. A good grubber, which can be worked by two pairs of moderate sized cattle will go over in a day as much ground as three ploughs of the English pattern; whilst it would probably take from seven to twelve pairs of cattle with native ploughs, and an equal number of drivers to do the same work with less efficiency.

HARROWS.—Of other implements used in preparing the land for crops, iron-prong and chain-harrows have been in constant use; the

latter are found to be of great value on light sandy soil for collecting weeds, covering seeds, and consolidating the soil; the former are rather heavy "seed-harrows," and are not so useful for general work as "drag-harrows," being besides much too costly.

A useful description of *drag-harrows* for cleaning dirty land has been made up in our workshops at a cost of about Rupees 25. They perform very good work, and can be made and repaired wherever there is a village smith; they are made to expand or contract, to fit them for any sort of work.

SEED-DRILLS.—A thirteen-row drill of Garret's pattern is in constant use, and has proved of much value, nearly all our crops are now sown with it, and the work is done efficiently, cheaply, and quickly; the cost of working this drill per diem is about:—

	RS.	A.	P.
1 pair of cattle and driver	0	12	0
1 man steering	0	3	0
1 man attending to seed	0	3	0
Oil	0	1	0
Total ..	1	3	0
Interest on capital wear and tear, &c., at 15 per cent. per annum on Rupees 300 charged on 60 working days	0	12	0
Total cost per diem ..	1	15	0

The machine sows about 5 acres a day, so that the cost of sowing is only six annas two pies per acre, a very moderate charge. The advantages of drilling seed over broad-casting are very well known, and for large holdings such a drill can be recommended.

On small holdings, however, a description of drill, such as one constructed out of an old broad-cast seed-barrow, is better adapted; it is fitted inside the hopper with rotary brushes fixed on an axle driven from the wheel, these throw the grain into the seed coulters, which are composed of loose tin funnels fitted into each other, as in the Garret's drill. The barrow has two seed coulters, but three can be used if necessary. The seed coulters can be regulated at pleasure to sow in lines from nine inches up to twenty-four inches apart, and by altering the gearing the speed of the elevating brushes can be increased or decreased, so as to sow a large or small quantity of seed. This drill will sow all the usual grains and pulses, raggy, cholum, tennay, shamay, varagoo, gingelly, cumboo, the grams, &c. With it three men on such soils as ours can easily sow about two acres per day. Drills of this sort can be made at Rupees 30 each—a moderate price when it is considered what sort of work they can perform.

Ordinary country bamboo drills may be turned out at a cost of not more than one-tenth of that of the barrow-drill, but the work performed by them is very indifferent; besides, where a number of different crops are grown, requiring to be sown in lines at varying distances apart, a separate drill is required for each, the seed coulters being fixed only to

sow at one width; again the country bamboo drill does not sow at a regular depth, and the quantity of seed it sows per acre altogether depends on the skill or watchfulness of the man who attends it. There is no guarantee of regularity. The sower may sow one part of a field at the rate of 50 lb. per acre, another part at 30 lb., and on other parts he may altogether omit to sow any seed. It is quite true that many ryots do excellent work with these very primitive implements; but then the ryot himself drops the seed into the seed coulters, he is not generally dependent on hired laborers, whose interest in the work is confined to getting over the land as speedily as possible. It is a serious matter to have land badly seeded, as the defect cannot be discovered until the crop appears above ground, when, owing to many circumstances unnecessary to detail here, it is frequently impossible to remedy matters; the only choice being either to plough and sow again, or to leave the crop with large blanks, in which weeds will grow and give endless trouble. There can be no doubt but that, on any holding on which 30 acres of dry crop are sown annually, the cost of a good seed drill will be more than repaid during each year in which it is used; not large complicated drills, such as are used in England and other countries, and mentioned above as suitable holdings where labor is costly, but such drills, as can be made at from 25 to 30 Rupees each. There is a class of superficial reasoners always ready to oppose the introduction of any improved implements or machines, if only these machines are more costly than those already used by ryots, altogether regardless of their superior efficacy over those in use. To such it may be said, what every thinking man must at once admit, that if a drill, costing 30 Rupees, will in a year return on thirty acres of crop one rupee per acre in excess of the amount a similar area of crop sown by the ordinary drill would yield, it must be to the ryot a much more desirable machine to possess than the one he already owns, though this may have cost him only one-tenth of the sum that he would pay for an improved drill.

The economy in the amount of seed required in drill-sowing is very great, amounting sometimes to five-sixths of that which is ordinarily used, especially is this the case with small seeds, such as raggy or indigo. To admit of interculture during the growth of the crop drill sowing is requisite, and of the value of after-cultivation there is no doubt, loosening, and cleaning the surface of the soil as it does.

HOES.—Associated with drill-husbandry is the use of the *bullock* or *horse-hoe*, sometimes called a cultivator; these implements, which are made for the purpose of stirring the soil between the rows of any crop, when working cut off and destroy many weeds, thus lightening the labor of hand weeding or hoeing; there are few indeed more useful implements to the Indian cultivator, especially when irrigation between the rows of standing crops is adopted. After watering, the soil usually becomes caked on the surface, and if water is again applied when the land is in that state it either runs off, or evaporates; when the cultivator is passed between the drills, shortly after the surface of the soil has begun to cake, it pulverises and opens up the soil, enabling it to absorb the dews and the water when next it is applied.

Besides bullock-hoes, a few *wheel-hoes*, for manual power have been made and used, but the general results have not been very encouraging.

They were made both with pronged and broad tines; but neither did the work as well as ordinary hand-hoes, while they cannot work as cheaply as those drawn by cattle. One or two have been supplied to tea plantations; for hoeing on the slopes of hills, they are probably well suited, it being a work in which they have not to compete with cattle hoes; while in forcing the hoe down or obliquely across a slope, it can be pushed with much greater force than over level surfaces.

Many varieties of hand-hoes have been tried, but it has been found best to use a heavy one like that used by coffee planters; in the dry season especially they can be used at times when light broad hoes, like those used for turnip culture in England, fail to penetrate the ground, and then of course the advantages of using hoes is especially great in killing weeds and increasing the absorptive powers of the soil. *Hoe-forks*, that is pronged hoes, have been found of use in digging over loose moist ground 3 or 4 inches deep, as for instance in a plantain garden, where cattle power cannot be made use of.

WATER-LIFTS.—The extension of cultivation under wells is admitted by all to be greatly desired in Southern India; for not only does this branch of husbandry enable crops to be grown during the dry weather or in droughty seasons, but it is also the one practice in native farming to which most care and intelligence is devoted. On lands which are watered thus, the ryot uses the little manure he ever applies to his farm, and in all respects is the agriculture of the "well" irrigated lands of a higher type than any other practised by him. The invention, application or introduction of economical water-lifts is therefore a work of great importance.

The Single Mhote, or inclined plane lift is well known throughout India. It has been described as follows:—

"The water is lifted from the well in a skin bucket, to the bucket is attached a rope which is fastened to the yoke of a pair of cattle; a roller or pulley is fixed about 4 or 5 feet higher than the discharging trough projecting slightly over the well, over this roller, or pulley, the rope travels as the bucket ascends or descends. The bullock path is an incline. When raising the bucket the cattle walk down the slope until the bucket reaches the full height and discharges its contents; the cattle are then backed up the slope, and the bucket sinking into the water, to be again raised by the forward motion of the cattle, and thus the process is again and again repeated. This arrangement is certainly very simple, it is however equally certain that the cost of raising the water by it is very great. With this machine a pair of cattle while raising only 6,900 gallons of water in a day are exceedingly hard worked in doing it; whilst backing up an incline with a slope of about 45 degrees, about forty times per hour, is a most effective way of rendering cattle worthless."

In comparison with the *Double Mhote*, which is an adaptation of the whim used for raising water and rubbish from mine-shafts in England, and in Australia for raising water for the stock, &c., the single mhote is inferior and will probably in time give place, although doubtless the prejudice, poverty, and habits of Indian ryots, will perhaps retard for a long time its general adoption. The first machine was erected in 1869, the driving part being copied from a model brought to this country from Australia by E. G. R. Fane, Esq., formerly the Collector of Chingleput; the rope arrangement and buckets were copied

from a sketch, which was supplied to the then Farm Committee by the Rajah of Vencatagiri. Since that time the machine has been much improved, and as it now exists on the farm, its mode of action has been described as follows :—

"The water is raised by two leather buckets, similar to those in ordinary use in most parts of this Presidency; to each of these buckets is attached a rope which is fastened to a drum ; one of these is coiled and the other uncoiled, as one bucket ascends and the other descends; the drum is fixed on a rotating spindle, to which is fixed at right angles the draught bar to which the bullock is attached ; the diameter and thickness of the drum varies with the depth of the well ; as a general rule, for all ordinary lifts the diameter of the drum may be equal to about one-fifth the number of feet that the water must be raised ; the drum is placed about 6 feet above the ground in order to allow the rope to pass over the head of the draught bullock ; the spindle upon which the drum is placed is kept in its upright position by means of two beams, into which it is fixed, which cross each other at the middle, and are supported at the ends on posts placed opposite each other on the outer side of the bullock path. The bullock walks under the draught bar attached to a curved yoke, which turns on a swivel. In raising water the bullock travels round the upright spindle, thus turning the drum and winding one rope and unwinding the other. If the diameter of the drum is as suggested 1½ circuits around the path will raise each bucket to the requisite height ; the bullock is turned round, facing the opposite direction, while each bucket is being discharged, no longer time is required to do this than is needed for the bucket to discharge its contents."

Comparing the two machines it may be said that the "double" will raise in a given time about 30 per cent. more water than the "single mhote," whilst the saving of cost in lifting a given quantity is about fifty per cent. One bullock is enabled to do the work of two, although he must be a stronger one, and probably more costly than the pair which suffices for the single mhote; the economy in number will not be of much weight where inferior cattle are, as is commonly the case, numerous and cheap. The erection of the single mhote is within the means of almost every ryot, and the whole apparatus can be repaired with his own hands ; whilst the double machine involves the outlay of a large sum of money and can only be repaired by a carpenter, if it gets out of order. The objection which exists in backing cattle up a slope of about 1 in 4 or 5 can easily be overcome by adopting the practice, common in some places, of using two pairs of bullocks ; allowing one to walk up alongside the track whilst the other is descending. The single mhote is not to be recommended, but it is suitable to the wants and habits of the native, and is therefore likely to hold its own for many years. Regarding the double mhote, an ingenious arrangement has been adopted on the Bangalore Experimental Farm whereby a pair of bullocks can be used for this machine ; Mr. Harman, the Superintendent, thus describes his improvements on the pattern in use at Saidapet, from which he took his original ideas :—

"The chief modification introduced is a wheel fixed by a vertical bar from the end of the beam to which the cattle are attached to equalize the balance, lighten the draft, and allow of a longer beam being used. The cattle can thus walk rapidly without turning giddy. The method of fastening the yoke for a pair of bullocks are employed, as bullock labor is plentiful on the farm."

The Picotta, or simple lever lift common to all oriental countries, works very well and cheaply for lifts under 12 feet; above that height it becomes expensive: a much better form of lift is used at Bangalore than that common in this neighbourhood.

The Bale.—For low lifts of from 1 to 2 feet, this mode of raising water is simple and cheap. In the same position, the *Archimedian Screw* can be used.

Bucket Pumps, for cattle power, are costly, and not very effective machines; the wear and tear on them is great, and their prime cost places them beyond the means of ordinary ryots.

Chain Pump.—One of these machines for cattle power has been made use of several times. It was found to constantly require repairing; irregular driving causing frequent breakages. The speed obtainable with cattle is not sufficient to work this machine well.

Description of Machine.	Height of lift.	Raised per hour.	Required to water one Acre of Ground one Inch deep.	Men required.	Cattle required.	Cost of Machine and of its erection.	Daily Cost. Manual labor.	Daily Cost. Cattle labor or fuel.	Daily Cost. Interest on capital, and cost of repairs and other charges, charged over 250 days.	Cost of raising 1,000 cubic feet of water.	Cost of raising 1,000 cubic feet of water 1 foot high.
	FT.	C. FT.	HOURS.	NO.	NO.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	A. P.	PIES.
Double Mhote	20	384	9·45	1	1	135 0 0	0 3 0	0 4 0	0 1 4	2 5	1·45
Single do.	20	256	14·18	1	2	25 0 0	0 3 0	0 8 0	0 0 3	4 11	2·95
Picotta	12	290	12·52	3	..	10 0 0	0 9 0	....	0 0 1	3 5	3·42
Do.	5·75	368	9·86	1	..	6 0 0	0 3 0	....	0 0 1	0 11	1·91
Double Bucket Picotta	7·5	560	6·48	2	..	10 0 0	0 6 0	....	0 0 1	1 2	1·87
Archimedian Screw lift	2	400	9·08	1	..	45 0 0	0 3 0	....	0 0 5	0 11	5·50
Burgess and Keys' Bucket pump ..	22	448	8·10	1	2	380 0 0	0 3 0	0 8 0	0 3 8	3 8	2·00
Steam do. ..	28	3,840	·95	3	..	5,000 0 0	1 10 0	6 14 0	3 0 0	5 4	2·29
Chain pump	12	250	14·52	1	1	500 0 0	0 3 0	0 4 0	0 4 10	5 3	5·25

BARN MACHINERY.—There is very little scope for the introduction of this class of machines into this country. *Threshing Machines* have yet to be invented which are adapted to clean our ordinary cereals; with the larger ones, cholum and cumboo, the straw is too long and stiff to pass through the machines, whilst to cut the crop at two operations in the field is expensive; with the minor cereals, raggi, tenai, &c., the straw is weak and winds round the drum, and the beaters do not remove more than a quarter of the grain, which adheres most persistently to the ears; whereas with paddy a few blows of the sheaf on a block of wood does all that is required, at an extremely low cost: as long as three men can be hired for a day's work at a shilling, or until a suitable machine has been invented for our special grains, there is little, if any, probability of, or use in endeavouring to urge the introduction of threshing machines.

Winnowing Machines on the other hand present very many great advantages to recommend their use to the Indian ryot; at present he is altogether at the mercy of the weather, which is undoubtedly generally fine for long periods of the year, in preparing his grains for market, but did he possess winnowing machines he would be better able to take advantage of the rise and fall of prices, and to sell out his crop, not as he now does, flushing the markets and depressing the prices to his own loss in doing so, as soon as ever the crop is off the ground, but whenever the most favorable opportunity occurred for realising good prices; the increased price which enterprising men would gain by using such machines would soon repay the capital they had sunk, whilst in the end greater steadiness would prevail in the price lists of the country. The superior speed and efficiency with which a winnowing machine cleans all descriptions of grains cannot be denied, and, except for very small tenants, where the labor of the family is not counted, no doubt grain can also be cleaned much more cheaply with them. Small machines can be introduced from America at a cost of Rupees 45 delivered, at which price, the charge per diem, estimating the machine to be used 50 days annually, would be about half an anna, to cover all charges for interest, wear and tear, &c.; a ridiculousy small amount.

Several varieties of *Maize-Shellers* have from time to time been tried, the one in use on the farm now is an American one; it is very simple, efficient and portable, and costs delivered only Rupees 40 and it will shell about lb. of maize in an hour. The following table compares the work and cost of two other maize-shellers which have been experimented with:—

—	Ransome's and Sim's.	Ainsworth's.	Eagle Sheller.
	RS. A. P.	RS. A. P.	RS. A. P.
Cost of machine	170 0 0	37 8 0	40 0 0
Shelled per diem, cobs	3,150 lb.	4,500 lb.	10,400 lb.
Coolies required to work	3	2	2
Cost—			
Labor	0 9 0	0 6 0	0 4 0
Interest wear and tear, &c.	0 2 8	0 1 6	0 1 7
Oil, &c.	0 0 4	0 0 4	0 0 2
Total ...	0 12 0	0 7 10	0 4 9
Cost per 1,000 lb., cobs	0 3 10	0 1 9	0 0 6

Chaff-cutters have been in constant use on the farm for many years; their value lies in economizing the food of cattle and in enabling substances, which could otherwise not be so used, to be given as fodder. From time to time chaff-cutters have been obtained from America; they are made on a much better principle than English chaff-cutters: instead of the cutting knives being fixed on the spokes of the fly wheel as in the English chaff-cutter, they have cylindrical knives set something like those of the lawn mower, the feeding roller being placed immediately behind the knives. The cutting action is thus continuous and less jerky than in the chaff-cutter with vertical cutters, while by increasing or decreasing the speed of the feeding roller, the chaff can be cut at different lengths. They are admirably suited for cutting all sorts of thick straw, for cholum or maize straw they are especially suited. It was found that the American machine could chaff cholum or maize straw at 30 per cent. less cost than the English machine, though the first cost of the latter is nearly 40 per cent. greater, proving that a low priced machine does not necessarily perform the cheapest work, and that an efficient machine, though its first cost may seem high, is often the cheapest machine in the long run. This is too frequently lost sight of by those who would provide the ryots only with the rudest description of implements and tools. In the instance just referred to the extra charge for interest and wear and tear on the more costly machine is only two pies per diem, a very insignificant sum, when it is remembered that with such a machine the manual labor expended will go 50 per cent. further than with the less costly machine.

In the following table the cost of chaffing with several machines is tabulated :—

—	American Cylindrical Cutter.	English Vertical Cutter.
Cost of machine	Rs. 50 0 0	Rs. 36 0 0
Chaffed per diem cholum or maize Straw.	lb. 630	lb. 495
Coolies required	2	2
Cost of—		
Manual labor	Rs. 0 6 0	Rs. 0 6 0
Interest, wear and tear charged over 250 days.	„ 0 0 5	„ 0 0 3
Oil and Sundries	„ 0 0 3	„ 0 0 2
Total ...	Rs. 0 6 8	Rs. 0 6 5
Cost of chaffing 1,000 lb. of Straw...	Rs. 0 10 7	Rs. 0 15 10

A *cake-breaking* and *grain-crushing* machine is in constant use, the following is a summary of the daily cost of working :—

	Cake-breaking	Grain-crushing
Value of machine	Rs. 165 0 0	
Days work	5,400 lb.	2,400 lb.
Men required	3	2
Cost—		
Labor	Rs. 0 9 0	Rs. 0 6 0
Interest, &c.	„ 0 1 0	„ 0 1 0
Oil and Sundries ...	„ 0 0 3	„ 0 0 3
Total ...	Rs. 0 10 3	Rs. 0 7 3
Cost per 1,000 lb. ...	Rs. 0 1 11	Rs. 0 3 0

Cotton-gins.—Generally cotton is ginned by one of Emery's gins with thirteen saws, made by Burgess and Key; having been found to work more cheaply with cattle, that power is now always used; the following are some comparative results, they are however considerably better than those obtained in ordinary practice :—

Nature of Power used.	Cattle.	Manual.
Time working	7½ hours.	7½ hours.
Amount of seed cotton ginned ...	262 lb.	135 lb.
Would gin in a full day	315 „	162 „
Labor required—		
Coolies	2	6
Cattle	1 pair.	...
Cost of labor per diem	Rs. 0 15 0	Rs. 1 2 0
Interest on capital, wear and tear, &c.	„ 0 8 0	„ 0 8 0
Total daily cost ...	Rs. 1 7 0	Rs. 1 10 0
Cost of ginning 1,000 lb. seed cotton...	Rs. 5 7 9	Rs. 12 0 7

INDEX.

Page

Analysis of Farm soils 7
,, of limestones 24
,, of cotton seed 22
,, of castor cake 22
,, of Bassia-nut cake .. 22
,, of pulses 94
,, of ground-nut cake .. 96
Alluvial earth as manure 23
Animal charcoal as manure .. 26
,, ,, experiments with 30
Artichokes, growth of 68
Artificial foods 94
Areca-nut palms, growth of .. 70
Ashes as manure 23

Bale, the 112
Bassia-nut cake 22
,, ,, experiments with .. 30
Barn Machinery 114
Beef, cost of manufacturing .. 98
Bengal-gram, growth of 52
Bone dust as manure 25
,, charcoal as manure 26
,, ,, experiments with .. 30
Box feeding, advantages of .. 20
Brinjals, growth of 67
Bucket pumps 112
Buckwheat, growth and uses of .. 69
Buffaloes, usefulness of 73
Buildings, &c. 6
Burmese paddy, growth of 44
Butter-making 80

Calcium sulphate 25
,, ,, experiments with 26, 27, 28
Cattle, management of 72
Cake-breaking machines 116
Carolina paddy, cultivation of .. 44
,, hints for do. .. 45
Castor cake as manure 22
,, ,, experiments with .. 33
Climate of district 2
China grass for fibre, growth of .. 64
Chaffing fodder 102
Chaff-cutters 115
Chinese sugarcane, growth of .. 40
Cost of keeping Farm cattle .. 75
Cotton, growth on sandy soil .. 54
,, New Orleans 55
,, linting season of 55
,, Egyptian 58
,, Yca Valley 59
,, Bahmieh 61
,, Indigenous 61
,, seed as manure 21

Page

Common millet 43
Country paddy, growth of 43
Crops, early harvesting of 36
,, fodder 31
Crow-foot grass or ragi 42

Dairy experiments 75
Deep cultivation 9
Drainage, objects of 12
,, cost of 16
,, difficulties of 14
,, experiments in 15
Double mhote .. .. .. 1[illegible]0

Early harvesting of crops 36
Egg-plant or brinjal 67
Egyptian clover, growth of .. } 69
,, beans, growth of .. }
Elephant grass as a fodder crop .. 51
Estate, history of 6
Exhaustion, cause and prevention of. 19

Farm estate, description of 5
Farm-yard manure 20
Fattening cattle 99
,, sheep 101
,, pigs 98
Feeding, principles of 91
Fields of the Farm 5
Fibre, experiments in manufacture of. 62, 63
Flax, growth of 69
Form of cattle 73
Formation of Farm, history of .. 6
Fodder crops, abundance of .. 35
Fodders, feeding value of various, experimented on. 92

Geological formation of district .. 1
Gins, cotton 116
Green manuring, action of 21
Great millet or yellow cholum .. 40
,, ,, as a fodder crop .. 35
Grasses, experiments in growth of .. 47-50
Ground-nuts, growth of 54
Gram, boiled and steeped as food, experiments with. 95
,, and ground-nuts compared as foods. 96
,, and maize do. do. 97
Grain-crushing machines 116
Guinea-grass, cultivation of .. 47
Guano, Phospho, as manure .. 25

	Page
Guano, Phospho, experiments with ..	27
Gypsum as manure	25
Hariali grass as a fodder crop ..	49
Harrows	107
Hoes	109
Horse-gram as a fodder crop ..	51
,, as a green manure ..	21
Housing cattle	72
Imphee, growth of	41
Indigo, wild	52
,, cultivation of	52
Indigenous grasses, experiments with.	50
Italian millet, growth of	42
Irrigation, objects of	11
Jute for fibre, growth of	63
Lentils, growth of	69
Lime as manure	24
Limestones, analysis of	24
Little millet, growth of	42
Lucerne, growth of	53
Locust bean tree, growth of ..	69
Maize, large producer	37
,, depth for sowing	38
,, under occasional irrigation ..	39
,, as a fodder crop	40
,, and gram as foods compared.	96
,, and ground-nut cake do.	97
,, shellers	114
Manures, classification of	19
,, experiments with ..	26 to 34
Manuring, objects of	19
Manilla hemp, growth of	64
Mhote, single	110
,, double	110
Mutton, manufacture of	101
Night-soil, village, as manure, experiment with.	30
,, manufacture of	23
Objects of the Farm	6
Paddy, country, as a fodder crop ..	43
,, Carolina	44, 45
Paddy, Burmese	44
,, bad type of crop	43
Pasture, poor quality of	91
Picotta, the	112
Pigs, management of	85
Planter's Friend, growth of ..	41
Plantains, growth of	66
Ploughs, descriptions used	103
,, experiments with	104
Poultry—Fowls	87
,, Ducks	89
Prickly Comfrey, growth of ..	69
Rainfall at the Farm and at the Observatory.	3
Ragi or crow-foot grass, growth of ..	42
Rape, growth of	69
Rheea for fibre, growth of	64
Rotations of crops	16
Roselle, growth of, for fibre and seed.	61
Saltpetre as manure	26
Seed drills	108
Sheep, Saidapet breed of, description	87
,, management of flock	84
Single mhote	110
Situation of Farm	1
Slaughter-house refuse, as manure ..	22
Spiked millet, or cumboo, growth of.	42
Soils of Farm, description of	7
,, analysis of	7
,, settlement values of ..	8
Sorghum saccharatum	40
Sugarcane, cost of growing ..	36
Sunn-hemp for fibre growth of ..	62
Tapioca, growth of	68
Threshing machines	114
Tobacco, growth of	64
,, curing of	66
Vetches, growth of	69
Water, cost of raising	113
Water-lifts	110
Wheat, difficulties of growing ..	37
White cholum, growth of	40
Wild indigo, as a sheep food ..	52
Winnowing machines	114
Wool production of Saidapet sheep ..	82
Working of Farm cattle	74